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RECENT DEVELOPMENTS IN MASS SPECTROMETRY: In the fields of chemical analysis and process control, recent years have seen many attempts to provide new and improved methods for accurately determining the qualitative and quantitative composition of gaseous and/or liquid mixtures. Numerous physical methods employing the use of refractive indices, densities, and various excitational and optical phenomena have been devised. Infrared and ultraviolet absorption and the Raman effect have been found useful in the examination of many of the simpler mixtures, and have been proved very satisfactory in this work.

All of these methods suffer from rather severe limitations, either because of their nature or because of restrictive practical considerations.

By contrast, in the present state of the art, the mass spectrometer can be generally extended to all mixtures whose components are fully vaporized at a pressure of 20 to 40 microns at normal temperature.

The clarity of the spectral data available from the mass spectrometer is at once evident upon comparison with the spectrum obtained from the optical methods previously mentioned. Here one is measuring by electronic means a fundamental unit—that is, mass. One rather serious drawback, however, which until recently has seemed to place a limit on the scope of applications for the mass spectrometer, is the high initial cost of the instrument in its conventional commercial form.

The recent advent of what may be referred to as high-frequency mass spectrometers may largely alter the outlook for mass spectrometer application. By offering the possibility of meeting the demand for a relatively low-cost instrument of limited mass range without losing any of the fundamental advantages of the general mass-spectrometric method, these new instruments may soon play an important role in industrial processes.

General Electric Review
November 1951

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Aircraft Nuclear Propulsion Project

AIRCRAFT NUCLEAR PROPULSION: One pound of uranium-235 will liberate heat, on undergoing fission, equivalent to the energy liberated by burning 1,700,000 pounds of gasoline. It is at once evident, if a means can be found for converting the energy of nuclear fission into thrust, that aircraft can fly for very long times on very small amounts of fuel. Indeed, fuel consumption would be measured not in thousands of pounds per hour, but in pounds per day.

In many respects the propulsion of aircraft is an ideal use for nuclear energy. Here, to a higher extent than in any other application, the advantages of a highly concentrated source of heat can be used to good result. Although the goal of producing a nuclear-powered aircraft is an admittedly ambitious one, it is only such high-performance, premium uses of energy which can today justify the consumption of as rare a resource as uranium-235 or plutonium-239. Moreover, it is inescapable that a development of this type has great military significance.

In recent months the government has announced that the nuclear aircraft program is entering a new phase. In this new phase, the Aircraft Gas Turbine Department of the General Electric Company has been given the responsibility for the propulsion system, and the Consolidated Vultee Aircraft Corporation is to supply an airframe.

My belief is that our efforts to fly an aircraft on nuclear power will be successful. The difficulty of the task and the value of the result combine to form a challenge which is, in my opinion, unmatched.

Chicago Section,
Institute of the Aeronautical Sciences
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The Mitochondrial System

IN THE early 1940s the belief was fairly general that the individual enzyme was the only catalytic unit to be reckoned with. The discovery by Krebs of the citric acid cycle initiated studies in several laboratories which led to the conclusion that the full complement of enzymes necessary for carrying out the cycle was associated with particles common to all types of animal cells. Two developments that followed in rapid succession helped clarify the biological significance of particle-bound enzymes. In 1946 the hypothesis was advanced that these particles were the structural units of an organized, integrated complex of enzymes (the cyclophorase system), which implemented the citric acid cycle and ancillary reactions, and the operational principles of which appeared to be unlike those obtaining for the soluble, isolated enzymes that presumably originated from the complex. For example, the enzyme complex showed no requirement for added coenzymes, and it catalyzed processes such as oxidative phosphorylation and the complete oxidation of pyruvic acid and fatty acids, which then could not be duplicated with soluble enzymes. In 1948, the structural unit of the complex was identified independently by Lehninger and Potter as the mitochondrion.

A new unit of enzyme chemistry thus emerged—a mosaic of more than a hundred enzymes linked together to form a huge macromolecule. Three developments helped prepare the way for the successful reconstruction of integrated activity in nonmitochondrial systems. In order, they were the demonstration by Lipmann and his group of the key role of coenzyme A in a variety of reactions involving transfer of acyl groups; the studies by Barker and Stadtman of fatty acid oxidation and synthesis in a cell-free soluble extract of Cl. Kluyverii-studies, which have adumbrated many of the reaction principles that apply to the mitochondrial system; and, finally, the recognition of heart muscle as the tissue of choice for solubilizing the fragile enzymes of mitochondria.

The Symposium on Phosphorus Metabolism, held at The Johns Hopkins University in 1951, marked the end of the period in which certain reaction sequences could be studied only at the mitochondrial level. As a result of work in four different laboratories (Cohen, Ochoa, Racker, and Green), all the known integrated activities of mitochondria have now been duplicated in nonmitochondrial systems. These activities include synthesis of citrulline from ornithine, synthesis of citrate from pyruvate and oxalacetate, oxidative phosphorylation, and the complete oxidation of pyruvate and fatty acids. There are several features characteristic of these reactions. They all require an energy source provided either by ATP or by some oxidative reaction. This "energizing" reaction involves the activation of the substrate through the intermediation of coenzyme A. The activated substrate (CoA-linked) is then transferred from one enzyme to another and undergoes reaction without at any time being in equilibrium with the corresponding nonactivated molecules. Such a reaction sequence calls for the intimate collaboration of a group of enzymes and thus again, even in soluble extracts, the catalytic unit for the over-all reaction is no longer the individual enzyme but a team of enzymes. As work along these lines is continued, we may anticipate further clarification of the significance of the organizational features of the mitochondrial unit.

D. E. GREEN
Institute for Enzyme Research
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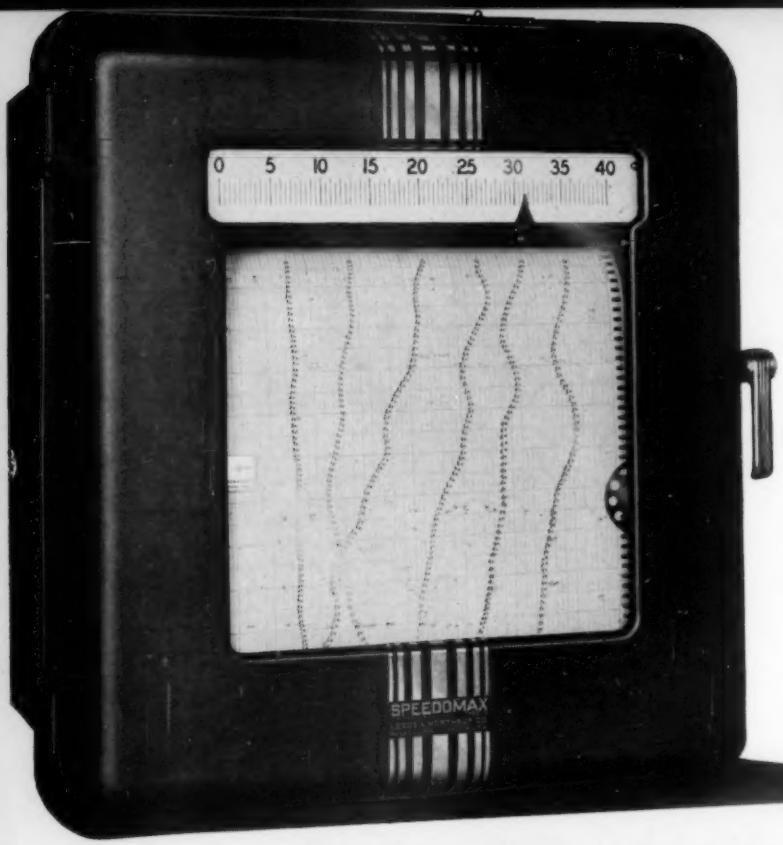

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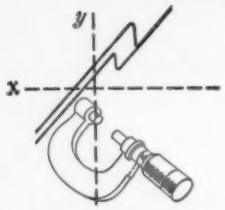

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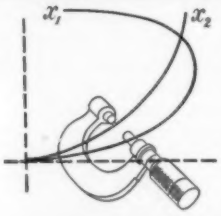

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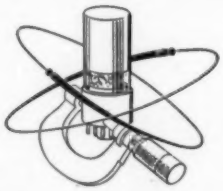

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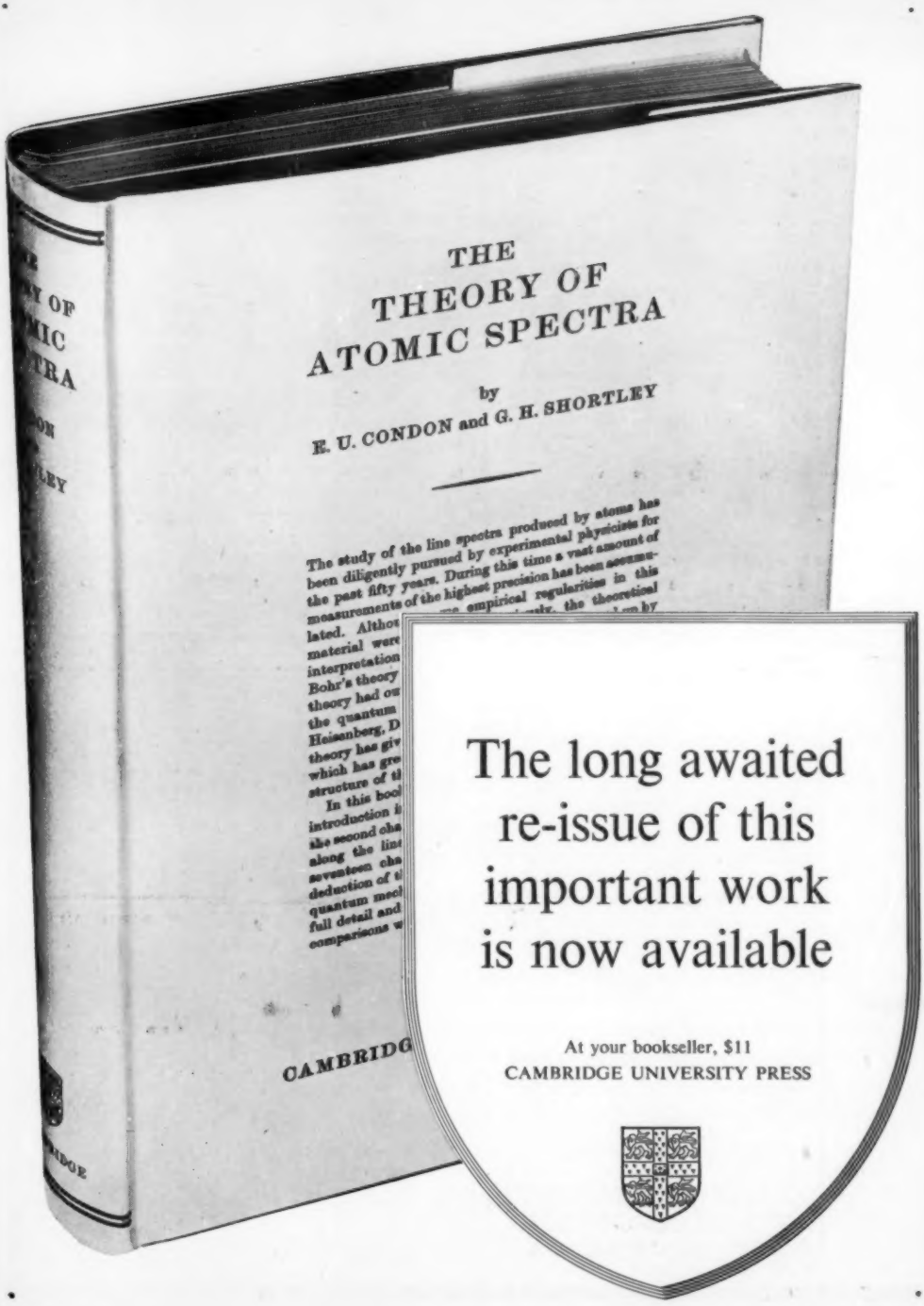
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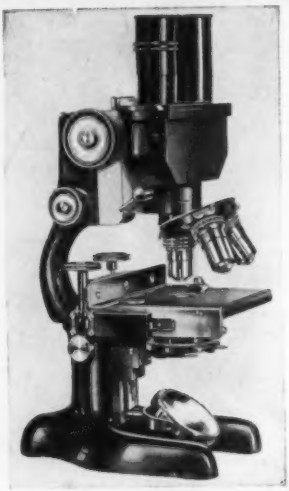

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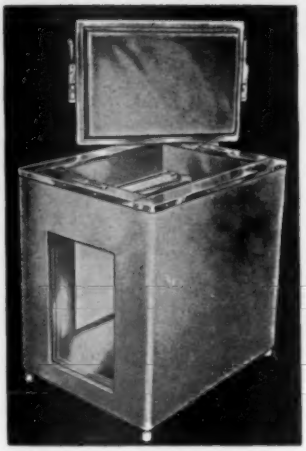

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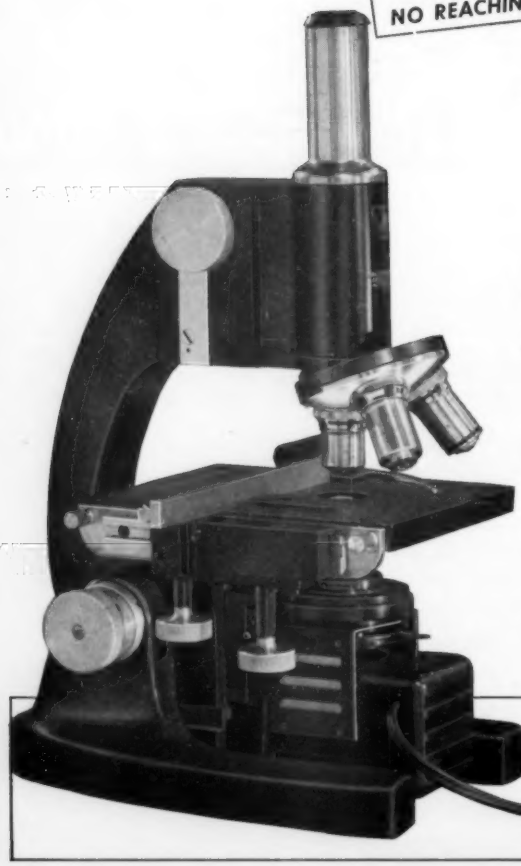

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Partial Reinforcement and Conditioned Heart Rate Response in Human Subjects

J. M. Notterman,[1] W. N. Schoenfeld, and P. J. Bersh[2]
Department of Psychology, Columbia University, New York

IN A RECENT REVIEW of the experimental literature concerned with partial reinforcement, Jenkins and Stanley (*1*) state that "Most of the research in this area has involved responses of the skeletal musculature rather than behavior innervated by the autonomic nervous system." The present note deals with the latter case, in particular with the use of a partial reinforcement schedule for conditioning changes in the human heart rate. It has been shown that changes in heart rate are successfully conditioned by means of a regular reinforcement schedule (*2*). In the latter study, it was reported that a previously neutral stimulus acquires the power of exercising a depressant effect upon the heart rate, following the regular pairing by the trace conditioning technique of that stimulus with electric shock to the hand. Curves of conditioned response strength were obtained for successive trials during conditioning, extinction, spontaneous recovery, reconditioning, and further extinction.

A survey of the literature reveals that several other researchers, beginning with Sherrington (*3*), have observed conditioned changes in heart rate when some noxious agent was used as the unconditioned stimulus. Some of these investigators report conditioned cardiac decelerations (*3, 4*), others report accelerations (*5–7*), and still others report both (*8, 9*). Although these cases all involve the use of an aversive stimulus as the reinforcing agent, it is difficult to determine whether there is anything else in common among them, or, on the other hand, if there are any systematic operational differences that might account for the disparate results. This difficulty exists principally for two reasons: (*a*) Some of the publications are in the form of abstracts and so contain few procedural details (e.g., intensity of noxious stimulus; temporal relations between CS and US; use of simultaneous, trace, or delay techniques; number of trials, etc.). (*b*) None of the human studies available contains any readily quantifiable data bearing upon the actual acquisition, extinction, spontaneous recovery, and reconditioning processes.

Complete details of the apparatus used in the present experiment are available in (*2*). In the main, the apparatus consisted of a cardiograph, shock circuit, and tone-oscillator circuit. The shock was 30 v a-c and was administered by means of two electrodes strapped to the palmar and dorsal sides of the left hand. The subject received a 750-cps tone, approximately 20 db, through a headset. The tone was of one second and the shock of six seconds' duration. On trials during which shock followed tone, a six-second interval separated the paired stimuli. There were six phases to the experiment, occurring in the following order: (1) determination of basal (preconditioning) heart rate response to the tone; (2) conditioning; (3) Extinction I; (4) spontaneous recovery; (5) reconditioning; and (6) Extinction II. The first three phases were administered in one session of approximately 1¾ hours' total duration; the remaining three phases, in one session of about 1¼ hours, some 24 hours later. The basal, Extinction I, spontaneous recovery, and Extinction II phases consisted of 20, 11, 10, and 11 tone-alone presentations, respectively, and were identical with similar phases for the previously reported regular reinforcement group (*2*). The conditioning phase consisted of 18 trials, of which 11 were tone-shock pairings, and seven were tone-alone trials. The reinforcement schedule of these 18 trials was as follows: the first five in the series were tone-shock, the remaining 13 were randomly presented tone-shock trials (six) and tone-alone trials (seven). The randomization of reinforced and unreinforced trials was not begun with the first trial, because it has been found that responses become conditioned more readily under partial reinforcement schedules if some response strength is built up initially with regular reinforcement (*1*). The reconditioning phase likewise consisted of 11 tone-shock and seven tone-alone trials, but randomization of reinforcement was begun after a single tone-shock presentation. The number of tone-shock combinations given during conditioning and reconditioning in the present experiment was precisely the same as that given the subjects of the regularly reinforced group reported in (*2*). Hence, the sole difference in experimental conditions between the partial and regular groups lay in the presence of the seven randomized tone-alone trials during conditioning and during reconditioning.

All trials were separated by one to two minutes, and each subject's cardiogram was taken continuously from about 30 seconds before the tone to about 30 seconds after the shock, or normal time for shock, on each trial. Heart rate measures were taken by determining the period of the last two cycles immediately preceding onset of tone, and the period of the last two cycles in the six-second interval following tone (and, therefore, immediately preceding shock on

[1] Postdoctoral research fellow of the National Institute of Mental Health, USPHS, 1950.
[2] Postdoctoral research fellow, National Research Council, 1950.

TABLE 1

MEAN PRE-TONE AND MEAN POST-TONE HEART RATE (IN BEATS PER MINUTE) DURING SUCCESSIVE PHASES OF THE EXPERIMENT*

Subjects	Basal		Conditioning		Extinction I		Spontaneous Recovery		Reconditioning		Extinction II	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	73.2	73.3	77.0	70.3	78.5	63.2	88.3	73.3	81.6	71.6	84.7	72.4
2	87.1	87.3	87.9	85.2	88.8	83.9	80.7	78.5	82.1	79.7	85.8	79.5
3	67.2	67.5	67.2	65.0	70.6	68.1	61.5	60.4	61.7	58.2	63.3	60.9
4	92.7	87.2	92.6	86.5	88.9	84.5	99.1	92.8	92.9	86.6	90.2	84.4
5	90.2	88.4	84.4	78.7	82.9	74.7	95.0	80.4	89.0	77.6	88.1	75.4
6	90.4	92.2	88.7	82.1	86.0	80.4	83.1	82.1	81.3	78.4	81.7	78.2
7	54.0	52.7	54.6	47.7	53.9	46.5	54.0	50.3	52.5	48.1	49.2	44.6
8	74.2	71.8	70.5	66.0	68.7	65.3	69.4	64.1	67.1	65.2	67.4	64.9
9	74.3	76.9	74.8	68.0	68.4	65.1	78.7	76.1	71.1	65.6	65.1	62.0
10	66.6	70.1	72.2	66.0	69.2	62.6	76.7	67.6	73.6	70.3	76.3	69.4
Group mean	77.0	76.7	77.0	71.6	75.6	69.4	78.7	72.5	75.3	70.1	75.2	69.1
Level of confidence	$P > .05$		$P < .001$		$P < .001$		$P < .001$		$P < .001$		$P < .001$	

* The levels of confidence shown are for group mean pre-tone minus group mean post-tone differences within each phase. The basal means are for basal trials 11–20; the means for the other phases are for all trials within each phase.

the tone-shock trials). These measures, called the "pre-tone" and "post-tone" heart rate, respectively, were then converted to beats per minute.

The data of this experiment are concerned with two principal questions: Does an originally ineffective stimulus come to initiate a characteristic heart rate response as a result of irregular pairing of that stimulus with shock? If so, how does the response strength acquired under these conditions compare with that acquired under regular reinforcement?

The data in Table 1 relate to the first question. These data are the mean pre-tone and mean post-tone heart rate values in beats per minute for the ten subjects used, over each phase of the experiment. The table shows, for example, that subject No. 1 had a mean pre-tone heart rate during conditioning of 77.0 beats per minute (b/m), this figure being based on 18 trials. The mean post-tone heart rate for the same individual was 70.3 b/m. The *group* mean pre-tone value for all subjects during conditioning, 77.0, was obtained from the individual means shown in the pre-tone subcolumn. In all phases except basal, the individual means shown are for the total number of trials given during each phase. For basal, the individual means are for the last 11 of the 20 trials given, these latter trials being used because they are a more stable estimate of preconditioning heart rate (*2*).

Pitman's variation (*10*) of a nonparametric test by Fisher was used to determine whether the distributions of the individual mean pre-tone minus mean post-tone differences for each phase are significantly different from chance. (Nonparametric tests were used throughout the treatment of these data, because in some comparisons variance was heterogeneous, and distributions did not appear to be normal.) This test shows that the basal changes in heart rate are not different from those to be expected on the basis of random variation, whereas for each of the other phases the probability that chance variation accounts for the heart rate changes is slight ($P < .001$). It is thus apparent that a schedule of irregular or partial reinforcement can be used to establish a characteristic conditioned depression in heart rate.

Regarding the second question, several trends are indicated in the data:

1) *Acquisition*: The difference in conditioned response strength produced by regular vs. irregular schedules of reinforcement is slight. Table 1 shows

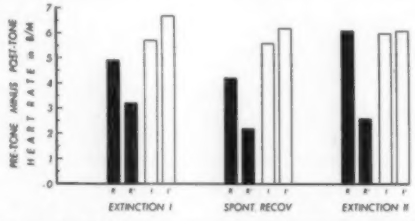

FIG. 1. Resistance to extinction of regularly and irregularly reinforced groups. Response strength of the first five trials (labeled *R* or *I*) is compared with response strength of the last five trials (*R'* or *I'*) for the indicated phases.

that, for conditioning (acquisition), the magnitude of the acquired heart rate depression in the present instance is 5.4 b/m (group mean pre-tone minus group mean post-tone heart rates). This value is quite similar to the 5.6 b/m drop reported in (*2*) for a regularly reinforced group. It may be noted parenthetically that, in view of reports by some previous investigators of conditioned cardiac acceleration under aversive stimulation, the present authors were interested in determining whether the *immediate* effect of the tone was to induce a heart rate speed-up, whereas the deceleration was simply a later effect. For this reason, heart rate measurements based on the first two cycles immediately following the tone were also taken during acquisition in the case of the regularly reinforced group. The data indicate a nonsignificant drop of 0.2 b/m compared to the pre-tone heart rate. Moreover, the heart rate appears to drop progressively throughout the six-second interval separating tone and shock.

2) *Reconditioning*: Here, too, the difference in con-

ditioned response strength produced by the two separate methods of reinforcement is only minor. Table 1 indicates that the reconditioning drop for irregular subjects is 5.2 b/m; for the previously reported regular group, the drop was 6.8 b/m. The difference between these drops is not significant ($P > .05$ by Pitman's spread test, based on rank-ordered data [*10*]).

3) *Extinction*: The most striking effect is found in terms of resistance to extinction; the irregularly reinforced subjects show a significantly greater perseveration of the conditioned response than do regularly reinforced subjects. Fig. 1 compares the resistance to extinction of the regularly and irregularly reinforced groups during Extinction I, spontaneous recovery, and Extinction II. Two pairs of columns are shown for each phase; the first pair (solid columns) depicts data of the regular group; the second pair, data of the irregular group. The first member of each pair of columns (marked *R* for regular, or *I* for irregular) gives the group mean pre-tone minus group mean post-tone heart rate for the first five trials of each respective phase. The second member of each pair (marked *R'* or *I'*) gives the corresponding change in heart rate for the last five trials of each phase. By comparing each group's level of conditioned heart rate response for the first five and the last five trials of each phase, differences in the perseverative tendency of the response may be noted. Thus, for Extinction I, there is a marked drop in the conditioned heart rate effect for the regular group, but a slight rise for the irregular group. In general, a diminution of conditioned response strength during the tone-alone trials is characteristic for the regular group; the irregular groups show either a slight rise, or no difference.

Table 2 gives a summary of the results of statistical comparisons made for the data illustrated in Fig. 1 (Pitman's nonparametric tests for correlated or uncorrelated items were used throughout, as appropriate). The probability values shown here, together with the data of Table 1, provide the basis for the following conclusions: (1) Heart rate changes may be conditioned in human beings by means of a schedule of irregular reinforcement. The fact that this autonomic response can be conditioned by such a technique meets a research need indicated by others (*1*). (2) The most conspicuous difference between the irregularly and regularly reinforced groups in the present research is in terms of the former's much greater resistance to extinction. It is noteworthy that this difference is obtained with an autonomically mediated response, inasmuch as the same effect has been almost universally observed with respect to motor responses (*1*).

TABLE 2

PROBABILITY VALUES FOR TESTS OF SIGNIFICANCE BASED UPON COMPARISONS OF EXTINCTION EFFECTS FOLLOWING SCHEDULES OF REGULAR AND IRREGULAR REINFORCEMENT

	R vs I	R' vs I'	R vs R'	I vs I'
Extinction I	$P > .05$	$.05 > P > .02$	$.02 > P > .01$	$P > .05$
Spontaneous recovery	$P > .05$	$P > .05$	$P > .05$	$P > .05$
Extinction II	$P > .05$	$.05 > P > .02$	$.03 > P > .02$	$P > .05$

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News and Notes

Scientists in the News

M. H. Arveson, technical director of the Indoil Chemical Co., has been elected director-at-large of the American Chemical Society. Originally named a director last April to fill the unexpired term of Edgar C. Britton, of the Dow Chemical Company, Mr. Arveson will now serve a full, four-year term.

Manuel Villafano Barajas, manager of the Comision de Fomento Minero, Mexico, is in this country to study and observe coal and iron mining techniques. His itinerary includes several mining operations, as well as visits in the Denver office of the Geological Survey and Bureau of Mines.

Albert F. Blakeslee, a past president of the AAAS and now director of the Smith College Genetics Experiment Station, has received an honorary doctor's degree from the Sorbonne. The degree was conferred at the annual meeting of the American Members of the Institut de France, of which Dr. Blakeslee is president.

Fred M. Bullard, professor of geology at the University of Texas, will be on leave from the university

for a year to study Italian volcanoes, including Vesuvius, Etna, Stromboli, and others, under a Fulbright grant.

For distinguished services to the Pineapple Research Institute and the pineapple industry of Hawaii, the Board of Trustees has designated **Walter Carter,** head of the Department of Entomology, as senior scientist of the Pineapple Research Institute.

Earl C. Chamberlayne has been appointed to the staff of the Pan American Sanitary Bureau, WHO Regional Office. Following a month of orientation at PASB headquarters, he will be assigned to the zone office in Lima, as area supervisor in veterinary public health, to conduct consulting services in this field. His area of operations will embrace Peru, Bolivia, Ecuador, Venezuela, Colombia, the Guianas, and the Netherlands Antilles. Dr. Chamberlayne resigned his position as director of food control in the Manitoba Provincial Ministry of Health and Public Welfare, in Winnipeg, in order to work with the PASB.

John M. Clark will be the first occupant of the new chair in political economy at Columbia University named in honor of his late father, John Bates Clark, who was a professor of economics at Columbia.

Oxford University has announced the appointment of **George W. Corner** to be George Eastman visiting professor for the academic year 1952–53. He is director of the Department of Embryology of the Carnegie Institution, located at Johns Hopkins Medical School, in which he also holds the title of professor of embryology. The Eastman professorship, endowed thirty years ago by George Eastman, is attached to Balliol College, Oxford.

Katharine Dodd, associate professor of pediatrics at the University of Cincinnati College of Medicine, and a member of the staff of the Children's Hospital Research Foundation, has been appointed professor and head of the Department of Pediatrics at the University of Arkansas School of Medicine. Dr. Dodd replaces **William A. Reilly,** who has accepted a position as chief of the Radioisotope Laboratory of the VA Hospital in San Francisco.

Robert C. Fuller has been appointed vice president in charge of production and research by Chesebrough Manufacturing Company. Mr. Fuller succeeds **Cyril Y. Emery,** who is retiring because of ill health. Mr. Fuller joined Chesebrough in 1945 as assistant to the vice president in charge of production and research.

Long Island University has named **William M. Hudson** acting president and dean of the College of Arts and Sciences. Professor Hudson has been director of students at the university. **Tristram Walker Metcalfe,** president of the university, has been ill since May. Professor Hudson joined the university as chairman of the Department of Economics and Sociology in 1928.

E. Kanda, of the Cryogenic Laboratory of the Research Institute for Iron, Steel and other Metals of Tohoku University, Sendai, Japan, has been a guest of the Cryogenics Laboratory of the National Bureau of Standards. Professor Kanda, who recently attended the Unesco Low Temperature Conference in Oxford, Eng., has returned to Japan.

J. Laurence Kulp (SCIENCE, **114,** 565 [1951]; **115,** 86 [1952]) was the twenty-fourth winner of the Newcomb Cleveland Prize (formerly the AAAS Thousand Dollar Prize), for his paper on "Natural Radiocarbon Measurements." Dr. Kulp, who is a geophysicist in Columbia University's Lamont Geological Observatory, described some of the newly developed techniques which were used in the carbon 14 method of dating deep-water samples.

F. V. Meriwether, after a 32-year career in the Public Health Service, the last two years in Atlanta as medical director for Region VI, has retired, and **R. A. Vonderlehr,** for five years medical director in charge of the Communicable Disease Center, was appointed to succeed him. **Justin M. Andrews,** deputy officer in charge of the center, succeeds Dr. Vonderlehr. All three officers hold commissions as directors (colonels) in the Regular Corps of the Public Health Service.

George E. Pfahler, of Philadelphia, received the gold medal of the Radiological Society of North America at its annual meeting, for outstanding achievement in radiology. **Joseph C. Bell,** of Louisville, took office as the society's new president. The president-elect, who will take office in 1952, is **Ira H. Lockwood,** of Kansas City, who has been chairman of the board of directors for the past year.

President Truman has accepted the resignation of **Sumner T. Pike** as a member of the Atomic Energy Commission. Mr. Pike has served on the AEC for more than five years and was the only remaining member of the original five-man commission.

In the Division of Forest Pathology of the Bureau of Plant Industry, Soils, and Agricultural Engineering, **C. Audrey Richards,** in charge of research on the deterioration of wood products at the Forest Products Laboratory of the Forest Service, is retiring after 34 years of service. **Ralph M. Lindgren,** formerly in charge of its cooperative investigations with the Southern Forest Experiment Station, takes her place, and **Arthur F. Verrall** takes over the studies of wood deterioration in the South. **Paul V. Siggers** has retired after 30 years of research, mainly on diseases of Southern pines, and is replaced by **Berch W. Henry,** Harrison Experimental Forest, Saucier, Miss.

Donald Stuart Russell, former assistant secretary of state, will become president of the University of South Carolina in June 1952. He will succeed **Norman M. Smith,** who revealed his plans for retirement two months ago.

Byron T. Shaw has been named administrator of

the Agricultural Research Administration, succeeding **P. V. Cardon,** who has retired following a career of 42 years as researcher, teacher, and administrator. Dr. Cardon will become assistant director of the USDA Graduate School. Dr. Shaw has been deputy administrator of ARA for nearly three and a half years, having been appointed to that position in August 1948. He had served as assistant administrator of ARA since early 1947.

Guy W. Thaxton has been appointed power engineer in the AEC Division of Construction and Supply. Mr. Thaxton was formerly regional power supply coordinator of the Defense Electric Power Administration.

Neely Turner, entomologist at the Connecticut Agricultural Experiment Station, has been appointed assistant director of the station. Mr. Turner joined the staff in 1927 as an assistant entomologist. He became associate entomologist in 1943, and entomologist in 1950.

Robert H. Whittaker, formerly assistant professor of zoology, Washington State College, Pullman, has joined the Aquatic Biology Unit, Radiological Sciences Department, Nucleonics Division, General Electric Company, Richland, Wash., to conduct research in radiological applications to synecology, dealing with food chains and functioning of natural communities.

Harry M. Zimmerman, chief of the laboratory division of Montefiore Hospital, has been appointed director of Yeshiva University's Medical School. It is the first appointment made to the new school, which is to open in the fall of 1953. Dr. Zimmerman is professor of pathology at the College of Physicians and Surgeons of Columbia University, has been a consultant in neuropathology at the Naval Hospital at St. Albans, and is a former president of the American Association of Neuropathologists.

Education

The **American Museum of Natural History** points out in its annual report that it has shifted its emphasis from collecting dead animals and artifacts to studies of living plants and animals and the chemistry and physics of their environment. The museum has research under way in cancer, petroleum exploration, psychology, conservation, and a special project to study the culture of the Soviet Union at long range. The new Felix M. Warburg Memorial Hall, opened in 1951, is a center for ecological research. More than two million people visited the museum in 1951.

John von Neumann, mathematician, of the Institute for Advanced Study, became **California Institute of Technology's** seventh visiting professor early this month. Jan H. Oort, astronomer, University of Leiden, was the sixth to join the staff. Other visiting professors at Caltech include David Bishop, biologist, of the University of Massachusetts; Noboru Yamada, plant physiologist, of the National Agricultural Research Institute, Konosu, Japan; Hans G. Borei, biologist, of the Wenner-Gren Institute; Egbert Havinga, chemist, of Leiden's Laboratory of Organic Chemistry; and E. G. Bowen, physicist, of Australia's CSIRO.

Chicago Natural History Museum has announced a program of 22 expeditions for 1952. Among them will be an expedition to the "Lost World" of Venezuela, under the direction of Julian A. Steyermark, curator of the herbarium; the eighteenth expedition to the American Southwest, under Paul S. Martin; studies at Parícutin by Sharat K. Roy, geologist; an exploratory trip to Austria by Rainer Zangerl, curator of fossil reptiles; an ornithological survey of Mexico, conducted by Emmet R. Blake. Bryan Patterson, curator of fossil mammals, has gone to Argentina on a Guggenheim Fellowship for a year of collecting and research. The Department of Zoology will also have outside collectors on expeditionary work: D. S. Rabor, of Silliman University, collecting birds and mammals in Guatemala; and Harvey A. Beatty, of New York, collecting birds in West Africa. Margery Carlson, botanist, of Northwestern, will collect for the museum on an expedition to southern Mexico and Honduras.

The **Council on Postgraduate Medical Education,** the **Pennsylvania Chapter of the American College of Chest Physicians,** and the **Laennec Society of Philadelphia** will sponsor the annual postgraduate course in diseases of the chest, which will be presented at the Warwick Hotel, Philadelphia, Mar. 24–28. Chevalier L. Jackson, of Philadelphia, president of the American College of Chest Physicians, is chairman of the committee arranging the course. Further information may be obtained from the executive offices of the college, 112 E. Chestnut St., Chicago 11.

A B.S. in materials engineering will be offered this year in the **University of Michigan College of Engineering.** The first-year schedule is identical with that for all other engineering students, with specialization beginning in the second year. Emphasis will be placed upon the corrosion resistance of, and protective coatings for, such materials as cement, wood, plywood, metals, rubber, and plastics.

The **Tissue Culture Association** offers its annual course of lectures and laboratory instruction, under the direction of John H. Hanks, of the Leonard Wood Memorial, Harvard. Designed specifically for M.D.s or Ph.D.s, the course will be given in the laboratories of the Mary Imogene Bassett Hospital, Cooperstown, N. Y., Aug. 6–28. Application forms, which must be returned by *Apr. 15,* may be obtained from Mary S. Parshley, College of Physicians and Surgeons, 630 W. 168th St., New York 32.

Western Reserve University will present in its 1952 Frontiers in Chemistry lecture series "Recent Advances in Physical and Inorganic Chemistry" on March 7 and 21, April 4 and 18, and May 2, and "Acetylene and Petroleum Chemistry" on March 14 and 28, April 11 and 25, and May 9.

Grants and Fellowships

The **American College of Chest Physicians,** 112 E. Chestnut St., Chicago 11, is offering an annual cash prize for the best original contribution, preferably by a young investigator, on any phase of chest disease. The contest is open to scientists in other countries, as well as to U. S. citizens, but the manuscript must be presented in English, before *Apr. 1.* Further information may be obtained from the college.

Armour Research Foundation has available fifteen industrial fellowships in physics, chemistry, metallurgy, ceramics, engineering mechanics, and electrical engineering, for the academic year beginning in September. The recipients will attend Illinois Institute of Technology half-time and work in the Research Foundation half-time, besides being employed full-time by the foundation during the summer. Applications received prior to *Mar. 15* will be given first consideration. For information write to the Office of Admissions, Graduate School, Technology Center, Chicago 16.

George Eastman House of Photography is the recipient of a gift of $100,000 from L. Corrin Strong, of Washington, D. C., as a memorial to Henry Alvah Strong, one of the financial backers of Mr. Eastman at the beginning of his career. The funds will be used for acquiring and preserving historical motion pictures, 90 per cent of which are on early nitrate stock. These perishable and inflammable films may now be copied on modern acetate safety stock, which will be stored in a building to be constructed by Eastman House and called the Henry A. Strong Archives.

Herman Frasch Foundation grants totaling $300,420 have been awarded to Caltech, Colorado A & M, Cornell, Ohio State, Rutgers, and the universities of Missouri and Wisconsin. The institutions will receive the grants in five yearly installments, pending approval of the progress of their projects by the American Chemical Society, which acts as consultant in administering the $1,000,000 foundation established by Elizabeth B. Frasch in 1924 in memory of her late husband, who was president of Union Sulphur Company.

Applications for **General Electric Company** fellowships must be filed by *Feb. 18* with the General Electric Educational Fund, Schenectady, N. Y. The fellowships will be awarded to graduate students for work in physical science, engineering, and industrial management under either the Charles A. Coffin Fellowship or the Gerard Swope Fellowship. General Electric has increased its aid to graduate students by raising amounts granted per student and by grants to the institutions to cover tuition and other costs formerly paid by the students themselves.

General Motors Corporation and the **Ford Motor Company** have made grants of $200,000 to Wayne University for expansion and maintenance of the large-scale computing machine laboratory at Wayne University. The university, now the owner of a differential analyzer and a cinema integraph, will acquire a digital computer, to be built at cost by Burroughs Adding Machine. Burroughs will also assist in the design.

Applications for **Public Health Service** research fellowships to begin between July 15 and March 14, 1953, should be filed by *May 1,* and for fellowships to begin between Nov. 15 and July 14, 1953, by *Sept. 1.* Applications and supporting documents should be sent to Division of Research Grants and Fellowships, National Institutes of Health, Bethesda 14, Md.

Annual **Tau Beta Pi Fellowships** for graduate study in engineering are intended to support an unmarried student, but some married applicants may be considered. Last date for filing is *Feb. 29.* For additional information, write Paul H. Robbins, 1121 Fifteenth St., N.W., Washington 5, D. C.

In the Laboratories

Ralph Bown, director of research for **Bell Telephone Laboratories** since 1946 and a member of the Bell System for more than 30 years, has been appointed vice president in charge of research. Much of his work has been in the various aspects of radio broadcasting and ship-to-shore and overseas telephony. Other changes at Bell Labs include the appointment of the following directors of research: J. B. Fisk, physical sciences; H. T. Friis, high frequency and electronics; W. H. Doherty, electrical communications. R. M. Burns, director of chemical and metallurgical research, has been appointed chemical coordinator.

Minneapolis-Honeywell Regulator Company has retained Larell B. Harmon, former director of school health service for the Texas State Department of Health, as a school consultant, and is underwriting an extensive research investigation into schoolroom heating conditions under Dr. Harmon's direction. The current work is a continuation of extensive studies already made by Dr. Harmon into the effects of improper lighting, seating, decorating, and other arrangements in the classroom on the health, development, and learning ability of school children.

Parke, Davis & Company is completing an ultramodern new laboratory to house the greater part of the Products Development Department. Thomas C. Anderson has been made director of production and engineering and will have charge of all such operations in this country and abroad. Dr. Anderson joined Parke-Davis in 1921 as a chemical engineer. Among others who will have new responsibilities this year are W. C. Richardson, who will be director of engineering and of overseas engineering and production liaison; Harvey M. Merker, named director of inventory control and consultant on chemical and pharmaceutical manufacturing; and John E. Sweitzer, assigned to handle an entirely new organization as director of industrial engineering.

Meetings and Elections

The **American Association of Spectrographers** is planning a symposium on "Instrumental Methods of Analysis in the Non-Ferrous Industry," to be held in Chicago in May. Contributed papers will be welcomed. Address all inquiries to Robert Raisig, Chairman, Symposium Committee, c-o Apex Smelting Company, 2537 W. Taylor St., Chicago 12.

The **British Association for the Advancement of Science** announces the following appointments for 1952, which will include the annual meeting at Belfast (Sept. 3–10) : president, A. V. Hill; general treasurer, M. G. Bennett; general secretaries, Richard Southwell and George Taylor; presidents of sections: A (Mathematics and Physics), A. M. Tyndall; B (Chemistry), W. Wardlaw; C (Geology), J. E. Richey; D (Zoology), A. D. Peacock; E (Geography), R. O. Buchanan; F (Economics), T. D. Jack; G (Engineering), Ben Lockspeiser; H (Anthropology and Archaeology), E. O. James; I (Physiology), R. C. Garry; J (Psychology), P. E. Vernon; K (Botany), Meirion Thomas; L (Education), A. L. Binns; M (Agriculture), N. C. Wright; Conference of Delegates of Corresponding Societies, J. A. S. Stendall. The prime minister of Northern Ireland and the lord mayor of Belfast will be patrons for the Belfast meeting, for which a local executive committee has been appointed under the chairmanship of Eric Ashby, vice-chancellor of Queen's University.

The **Centennial of Engineering** celebration to be observed in Chicago this year has appointed a 37-man board to direct the activities. Among the members are Benjamin F. Fairless, Gano Dunn, Herbert Hoover, Charles F. Kettering, David Sarnoff, James M. Todd, and Robert E. Wilson. Officers of the centennial are Lenox R. Lohr, president; Carlton S. Proctor, vice president; Titus G. LeClair, treasurer; and Charles F. Kettering, chairman of the Executive Committee. Frank W. Edwards, on loan from Illinois Institute of Technology, is general manager.

The sixth annual **Eastern Colleges Science Conference** will be held at Pennsylvania College for Women, Pittsburgh, Apr. 3–5. Three hundred Eastern colleges will be represented by 500 undergraduates. The theme will be "Science in an Industrial Era." The program will include tours, exhibits, lectures by specialists, and the presentation of undergraduate student papers and the exchange of student ideas.

The **Ergonomics Research Society** will hold a conference Mar. 25–28 at the College of Aeronautics, Cranfield, Bletchley, Bucks, Eng. Details of the program, which will cover the psychological, physiological, and industrial aspects of fatigue, may be obtained from K. F. H. Murrell, Room 1108, Queen Anne's Mansions, London, S. W. 1.

Papers to be read at the third annual meeting of the **Histochemical Society,** Hotel New Yorker, New York, Apr. 7–8, should be submitted to the secretary, R. D. Lillie, National Institutes of Health, Bethesda 14, Md.

A meeting of the **USA National Committee of the International Scientific Radio Union (URSI)** and the **Institute of Radio Engineers Professional Group on Antennas and Propagation** will be held at the National Bureau of Standards, Washington, D. C., Apr. 21–24. Sessions will be concerned with the following topics: Radio Measurement Methods and Standards; Tropospheric Radio Propagation; Ionospheric Radio Propagation; Terrestrial Radio Noise; Radio Astronomy; Antennas and Waveguides; Radio Waves and Circuits; and Electronics. A preliminary program and advance registration forms will be available after *Mar. 10.* Further information concerning the meetings may be obtained from A. H. Waynick, Secretary, U. S. A. National Committee of URSI, Pennsylvania State College.

Miscellaneous

President Truman has announced establishment of a **Commission on the Health Needs of the Nation.** Its chairman is Paul B. Magnuson, orthopedic surgeon and former chief medical director of the Veterans Administration. The commission has 15 members whose assignment is "to make a critical study of our total health requirements, both immediate and long term, and recommend courses of action to meet these needs." The survey will embrace such broad topics as the current and prospective supply of professional personnel, public health requirements, geographical distribution of resources and facilities, medical research, adequacy of private and public programs designed to provide methods of financing medical care. The President's action has been sharply criticized by John W. Cline, Gunnar Gundersen, AMA trustee who was appointed president of the American Medical Association, and to the commission, has declined to serve.

The **National Science Foundation** had received 2800 applications for its graduate fellowships by the closing date, Jan. 7. Alaska, Hawaii, Puerto Rico, the District of Columbia, and all the 48 states were represented. About 400 fellows will be selected from this group, after screening and evaluation by the NRC fellowship panels. The foundation has appointed an advisory divisional Committee on Scientific Personnel and Education to help develop national policies in this field. The members include Joel H. Hildebrand, Frank J. Welch, Douglas Whitaker, Katherine McBride, and Harry A. Winne.

The private collection of marine barnacle specimens and data belonging to the late J. Paul Visscher, former professor and chairman of the Biology Department of Western Reserve University, has been given to the **U. S. National Museum,** Washington, D. C. Believed to be the largest and finest of its kind, the collection includes microscopic slides, bottled and dried specimens, manuscript notes, and the barnacle portion of Dr. Visscher's library. Dr. Visscher died Feb. 11, 1950.

Technical Papers

The Absence of Dietary Effects on the DNA Content of Liver Nuclei of the Adult Rat

Rosa M. Campbell and H. W. Kosterlitz

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University of Aberdeen, Scotland

Ely and Ross (*1*) reported recently that in young growing rats fed on protein-deficient diets for periods of 8–49 days, the liver nuclei had a higher mean desoxyribonucleic acid (DNA) content than had nuclei obtained from livers of control animals fed on the stock diet.

In the adult rat, dietary variations do not seem to have similar effects. Campbell and Kosterlitz (*2–4*) found in a large number of rats that feeding of a protein-free diet for periods of up to 3 weeks and variations in the fat and choline contents of the diet had no influence on the DNA content of the liver. The only factors that appeared to determine the value of liver DNA were body weight and sex. Mandel, Jacob, and Mandel (*5*) showed that, when adult rats were fed on a protein-free diet for 50–75 days, no DNA was lost from the liver and the number of nuclei remained unchanged. In order to give further support to these findings, we have now determined the mean DNA contents of liver nuclei isolated by the method of Vendrely and Vendrely (*6*). Five male littermate pairs of rats with a mean initial body weight of 325 g were used, one member of each pair being fed on the stock diet and the other on a protein-free but otherwise adequate diet for 28 days. The mean DNA content was 10.8×10^{-6} μg/nucleus in the rats fed on the stock diet and 11.0×10^{-6} μg/nucleus in the rats fed on the protein-free diet. The standard error of the difference between the DNA values of the two groups was $\pm 0.48 \times 10^{-6}$.

The significance of these results is further underlined by the findings of Davidson and McIndoe (*7*) and of Mirsky and Kurnick (*8*). These authors found no change in the mean DNA content of rat liver nuclei after fasting, which in the experiments of Mirsky and Kurnick was continued until the livers had lost as much as half their original weight.

It would appear, then, that in the adult rat even such severe dietary conditions as prolonged fasting and prolonged consumption of protein-free diets have no significant influence on the mean DNA content of liver nuclei. The DNA content of the liver of the adult rat is thus a suitable standard of reference for those liver constituents which vary with altered dietary conditions. On the other hand, the findings of Ely and Ross (*1*) indicate that this is not the case in young growing rats, at least not if they are exposed to severe dietary deficiencies for long periods. Under these conditions, the normal growth of the liver is seriously interfered with, and changes in the DNA content of liver nuclei are therefore more likely to occur than in adult animals.

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A New Class of Organic Fungicides

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A series of new compounds has been synthesized by the reaction of perchloromethyl mercaptan with the alkali metal salts of imides and amides. The purified products obtained from these reactions are, in nearly all cases, colorless, crystalline, odorless compounds and are readily obtained in yields ranging from 80 to 95%. In a cooperative testing program with Rutgers University, the compounds were found to possess

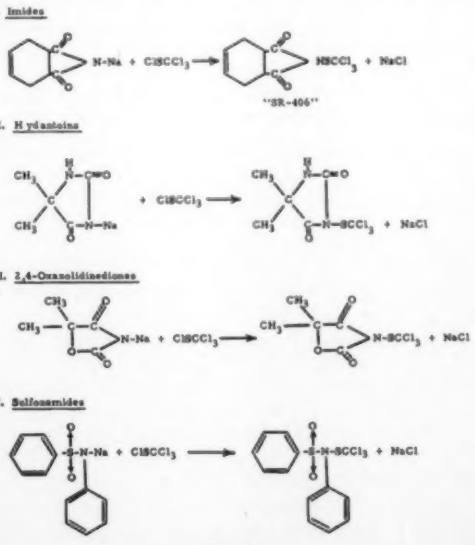

Fig. 1.

exceptional fungicidal activity. One of them, *N*-trichloromethylthio-tetrahydrophthalimide, which has undergone extensive fungicide field tests at numerous agricultural experimental stations in the United States, Canada, England, Denmark, France, and Latin America under the code identification "SR-406," is proving to be an especially promising agricultural fungicide. The results of these field tests will be reported elsewhere.

have been reacted with perchloromethyl mercaptan in the present work.

The $>NSCCl_3$ group, to which the fungicidal activity of the above classes of compounds is attributed, is thus readily introduced into compounds containing an $>NH$ group sufficiently acidic to form a stable alkali metal salt. A general procedure applicable to the preparation of this class of compounds is described below.

TABLE 1

N-TRICHLOROMETHYLTHIO DERIVATIVES OF COMPOUNDS CONTAINING THE $>NH$ GROUP

Parent compound	Empirical formula	MP° C (uncorr)	Analysis (%)			
				N	S	Cl
Phthalimide	$C_9H_4NO_2SCl_3$	176–177	Found	4.72	10.64	35.76
			Calc	4.71	10.81	35.96
Δ4-Tetrahydrophthalimide	$C_9H_6NO_2SCl_3$	172–173	Found	4.79	10.59	35.00
			Calc	4.67	10.67	35.50
Endomethylene-Δ4-tetrahydrophthalimide	$C_{10}H_8NO_2SCl_3$	152–153	Found	4.36	10.40	33.67
			Calc	4.49	10.25	34.13
Succinimide	$C_5H_4NO_2SCl_3$	140–141	Found	—	13.00	41.69
			Calc	—	12.90	42.94
5,5-Dimethyl-2,4-oxazolidinedione	$C_6H_6NO_3SCl_3$	88– 89	Found	5.16	11.46	38.32
			Calc	5.02	11.49	38.13
5-Methyl-5-ethyl-2,4-oxazolidinedione	$C_7H_8NO_3SCl_3$	83– 84	Found	—	11.20	36.29
			Calc	—	10.95	36.35
5,5-Pentamethylene-2,4-oxazolidinedione	$C_9H_{10}NO_3SCl_3$	111–112	Found	—	10.24	33.31
			Calc	—	10.38	33.38
5-Methyl-5-isobutyl-2,4-oxazolidinedione	$C_9H_{12}NO_3SCl_3$	89– 90	Found	—	10.04	32.99
			Calc	—	10.00	33.18
5-Cyclopropyl-5-methyl-2,4-oxazolidinedione	$C_8H_8NO_3SCl_3$	108–109	Found	4.59	10.45	34.77
			Calc	4.79	10.79	36.49
O-Benzosulfimide	$C_7H_4NO_2S_2Cl_3$	143–144	Found	—	19.22	31.85
			Calc	—	19.27	32.08
N-Phenyl-benzenesulfonamide	$C_{12}H_{10}NO_2S_2Cl_3$	112–113	Found	—	18.02	27.59
			Calc	—	16.74	27.88
5,5-Dimethyl-hydantoin	$C_6H_7N_2O_2SCl_3$	169–171	Found	10.16	11.49	38.42
			Calc	10.11	11.55	38.45
1-Nitro-5,5-dimethyl-hydantoin	$C_6H_6N_3O_4SCl_3$	125–126	Found	12.35	9.85	32.74
			Calc	13.04	9.94	33.08
1-Acetyl-5,5-dimethyl-hydantoin	$C_8H_9N_2O_3SCl_3$	94– 97	Found	8.75	10.02	32.70
			Calc	8.78	10.03	33.40
5-Methyl-5-isobutyl-hydantoin	$C_9H_{13}N_2O_2SCl_3$	133–134	Found	8.61	9.72	33.00
			Calc	8.77	10.03	33.38
Morpholine	$C_5H_8NOSCl_3$	86– 87	Found	—	13.46	44.39
			Calc	—	13.55	44.97

The reactions of perchloromethyl mercaptan with aliphatic and aromatic amines (*1–4*), alcoholates, and phenolates (*3, 5*) have been described previously by several investigators. In most cases the products from the reactions were reported to be unstable compounds which decomposed spontaneously on standing or by heating to 130°–140° C. In contrast, the derivatives of perchloromethyl mercaptan prepared in the present investigations have been quite stable under ordinary conditions. The condensation of perchloromethyl mercaptan with imides and amides to form stable compounds containing the *N*-trichloromethylthio group is a general reaction. The four schematic equations (Fig. 1) typify methods by which representatives of different classes of imides and related compounds

One mole of the sodium salt of an imide or amide is dispersed in 1000 ml of benzene in a 2-liter, 3-necked flask equipped with a stirrer, thermometer, reflux condenser, and dropping funnel. While stirring, one mole of perchloromethyl mercaptan is added from the dropping funnel over a period of 2–3 hr. During the addition of mercaptan the reaction mixture is heated slowly from an initial 25° C to refluxing temperature and stirred for an additional 4–6 hr. The benzene solution is filtered hot to remove precipitated NaCl. Isolation of the *N*-trichloromethylthio derivative is then accomplished by evaporating off a portion of the benzene filtrate, cooling, and filtering.

It has also been possible to prepare a closely related product, *N*-trichloromethylthio-morpholine by

the direct reaction of perchloromethyl mercaptan with morpholine. An excess of morpholine is employed in this synthesis to tie up the HCl formed in the reaction. *N*-trichloromethylthio-morpholine is a white crystalline material melting at 86°–87° C.

Sixteen compounds which were condensed with perchloromethyl mercaptan are listed in Table 1, along with the empirical formulas and melting points of the new organic compounds produced by the resultant reactions. Biological assays have shown that all the compounds exhibited an LD_{50} value of less than 10 ppm against the fungi *Alternaria solani* and *Sclerotinia fructicola* by the slide germination technique (*6*).[1]

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[1] The laboratory fungicide tests were carried out in the Standard Oil Development Company's cooperative project at Rutgers University under the supervision of R. H. Daines and Lyle E. Hagmann.

Pre-Cambrian Uraninite, Sunshine Mine, Idaho

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Uranium ore was first discovered in the Sunshine Mine, Coeur d'Alene district, Kellogg, Idaho, in the summer of 1949. Uraninite was subsequently identified as the responsible mineral and occurs in the vicinity of the Sunshine vein at various places from the 2900′ level to the lowest level at 3700′.

The mineral is found in veins somewhat comparable to the nonpegmatitic occurrences of the northwestern Canadian Shield. These veins are cut in a number of places by later siderite veins carrying silver-bearing tetrahedrite. The wall rock belongs to the St. Regis formation (pre-Cambrian quartzite).

Through the geological studies of Ransome and Calkins (*1*), Shenon and McConnel (*2*), and others, the general relationships of the silver veins are well known. The opinion has prevailed (*3*) that the mineral deposits of the Coeur d'Alene are associated with Mesozoic or later igneous activity. Recent reference to the uranium occurrence (*4*) places the uraninite after tetrahedrite, the common silver ore mineral.

Specimens of uranium ores supplied by R. H. Robinson, chief geologist of the Sunshine Mine, studied in the Mineralogical Laboratory of Columbia University, indicate an origin for the uraninite earlier than the tetrahedrite. Laboratory criteria are inadequate to demonstrate, however, whether the uranium was introduced merely at the beginning of the silver-precipitating epoch or during a distinctly earlier mineralization. Arrangements were made, therefore, to secure data for an age determination.

Through the cooperation of the Division of Raw Materials, AEC, both chemical analyses and lead isotope analyses have been secured. The material selected for analysis was collected on the west face of No. 16 stope in the footwall of the Sunshine vein, west of the Jewell crosscut and above the 3100′ level. Uraninite occurs in small veins and segments of veins associated with an alteration halo of fine-grained pyrite and red jasper. Small fragments were broken from vein specimens and examined microscopically for purity. Uraninite was identified by x-ray diffraction, the lattice constant being 5.4439. A chemical analysis of Sunshine uraninite with uraninite analyses from two other localities by Clara Gale Goldbeck, chief, Microchemical Branch, New Brunswick Laboratory, AEC, is given in Table 1. Isotope analyses by Roger Hibbs, chief, Mass Assay Laboratory, Carbide and Carbon Chemicals Company, Oak Ridge, are also included.

On the basis of the analyses, computations have been made by Kulp as given in Table 2 using 4.50×10^9 yr for the half-life of U^{238} and 7.07×10^8 yr for the half-life of U^{235}. Although the half-life of U^{235} has been a subject of debate during the past few years, the value of 7.07×10^8 accepted at present is essentially that proposed by Nier a decade ago.

An uncorrected age from $\left(\frac{Pb}{U + Th}\right)$ of 1050 ± 50 M.Y. is obtained from the graph published by Wick-

TABLE 1

CHEMICAL ANALYSES

	Sunshine	Martin Lake	Caribou
U_3O_8	26.9	67.5	40.77
Th and R.E.	—	—	1.7 (No Th)
SiO_2	18.2	0.42	
PbO	4.0	7.96	4.15
Al_2O_3	4.4		
Fe_2O_3	—	0.94	
Fe	13.1	—	3.15
CaO	.8	12.7	
MnO	—	0.85	
Mn	1.0		
CuO	—	—	0.55
Cu	7.7	—	
Ag	1.0		
Sb	2.6		
H_2O	1.1	0.62	5.3
CO_2	6.8	4.68	0.22
S	9.	0.01	8.3
V_2O_5		0.3	
NiO			0.34
ZnO			1.22
	Lead Isotopes		
208	17.84 ± 0.07	0.460 ± 0.013	50.67 ± 0.05
207	12.42 ± 0.05	7.32 ± 0.02	20.69 ± 0.03
206	69.20 ± 0.03	92.17 ± 0.01	27.27 ± 0.05
204	0.540 ± 0.010	0.044 ± 0.001	1.37 ± 0.02

TABLE 2

AGE CALCULATION

	Sunshine Mine specimen			
	204	206	207	208
Isotopes present	0.540 ± .01	69.20 ± .03	12.42 ± 0.05	17.84 ± 0.07
Assume for common lead	1.000	16.00 ± 1.0	15.35 ± 0.2	35.4 ± 1.0
∴ Original common lead	0.540	8.65 ± 0.50	8.29 ± 0.30	19.1 ± 1.0
∴ Radiogenic lead	—	60.55 ± 0.50	4.13 ± 0.4	Nil

$\therefore gPb^{206}/100g = 2.26 \pm 0.02$; $gPb^{207}/100g = 0.154 \pm .002$

$Pb^{207}/Pb^{206} = 6.8\% \pm 0.2$, $\therefore t = 850 \pm 50$ million years

$$Pb^{206}/U^{238},\ t = 1.501 \times 10^{10} \log \left(1 + \frac{1.15\ Pb^{206}}{U^{238}}\right) = 710 \pm 10 \text{ M.Y.}$$

$$Pb^{207}/U^{235},\ t = 2.37 \times 10^{9} \log \left(1 + \frac{158\ Pb^{207}}{U^{235}}\right) = 750 \pm 10 \text{ M.Y.}$$

man (*5*). The Pb^{206}/U^{238} age of 710 ± 10 M.Y. results from the equations derived by Keevil (*6*). On the same basis the Pb^{207}/U^{238} age is 750 ± 10 M.Y. The graphical solution given by Nier (*7*) was used for Pb^{207}/Pb^{206} and gives 850 ± 50 M.Y. If the radon loss is assumed to be the major source of divergence in the age ratios, and the Pb^{206}/U^{238} age is adjusted to equal the Pb^{207}/U^{235} age, it turns out that the Pb^{207}/Pb^{206} age also becomes 750 ± 50 M.Y. The unweathered condition of the material, the particle size, and the distribution of the uraninite make the assumption of radon loss as the main source of error quite reasonable.

The computed age of 750 M.Y. indicates that the Sunshine uraninite is much older than Mesozoic—i.e., is late pre-Cambrian. Since the fractures in which the Sunshine vein occurs cut the north limb of the Big Creek anticline (*2*) in which the Beltian sediments are folded, it is logical to assume that the original deformation must have been even earlier pre-Cambrian.

In order to confirm the determination on the basis of geological occurrence, data are included on uraninite from two other localities with considerably different age relationships. One locality is the Caribou Mine, near Nederland, Colo. (presumably Tertiary); the other, Martin Lake, near Beaverlodge, north of Lake Athabasca, Canada (presumably pre-Cambrian).

The computations on uraninite from these two localities are given in Tables 3 and 4.

The age of 890 M.Y. for Martin Lake is in reasonable agreement with other values on record for the general pre-Cambrian area. The Caribou data, however, strongly suggest that the uraninite is Tertiary.

In view of the variance of the Sunshine age determination from previous geological interpretations, additional study is being undertaken both to verify the current report and to further clarify the geological interpretation.

TABLE 4

AGE CALCULATION

	Caribou specimen			
	204	206	207	208
Observed	1.37 ± .02	27.27 ± 0.05	20.69 ± 0.03	50.67 ± 0.05
	1.000	18.00 ± 1.	15.5 ± 0.2	38.0 ± 1.0
	1.37	24.6 ± 1.3	21.2 ± 0.2	52.0 ± 1.5
	—	2.7 ± 1.4	Nil	Nil

$gPb^{206} = 0.105$

$Pb^{206}/U^{238} \longrightarrow 23 \pm 10$ M.Y.

(The large amount of common lead invalidates the uncorrected age.)

TABLE 3

AGE CALCULATION*

	Martin Lake specimen			
Lead isotopes	204	206	207	208
Observed	0.044 ± .001	92.17 ± 0.01	7.32 ± 0.02	0.460 ± 0.013
Assumed common Pb	1.000	16.00 ± 1.0	15.35 ± 0.01	35.4 ± 1.0
Original common Pb	0.044	0.70 ± 0.04	0.68 ± 0.004	1.56 ± .04
	—	91.47 ± .05	6.64 ± 0.02	(−1.10†)

Uncorrected age $\left(\frac{Pb}{U + Th}\right) \longrightarrow 870$ M.Y.

$gPb^{206} = 6.82 \pm 0.06$; $gPb^{207} = 0.495$

$Pb^{207}/Pb^{206} = 7.25\% \longrightarrow 900 \pm 10$ M.Y.

$Pb^{206}/U^{238}\ t = 860 \pm 5$ M.Y.

$Pb^{207}/U^{235}\ t = 980 \pm 5$ M.Y.

* If 890 is assumed as the true age and correction made for radon loss, as discussed above, then 206/238 becomes 890 M.Y., and the 207/206 ratio again is brought into agreement, becoming 890 ± 10 M.Y. The "uncorrected age" in this case is close to the true age simply because of the low concentration of common lead.

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The Natural Resistance of the Golden Hamster to Colchicine

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In the course of an investigation of the origin of tertiary giant cells in the pregnant uterus of the hamster, *Cricetus auratus,* it was decided to use colchicine to study proliferative growth. Doses varying from .1 mg up to 2 mg/100 g of body weight were injected, and the animals were killed 6–21 hr thereafter. No significant variation from the normal number of mitoses was observed, and the presence of anaphase and telophase stages with normal spindles in normal ratio suggested that these doses were ineffective. A review of the literature indicated that the effective dose in other rodents, mice, rats, and guinea pigs, and in rabbits, is usually just below the lethal level. In an attempt to establish the effective dose, and to test the potency of the colchicine used, a series of hamsters, mice, rats, and one rabbit were injected intraperitoneally from the same solution of colchicine, injections varying in concentration from 0.12 to 7.0 mg/100 g of body weight. Young mature males were used for this entire series. Time of injection, concentration, and subsequent history were recorded, the animals being checked in the morning, during the day, and in the evening. The results are recorded in Table 1.

Both rats and mice, and also the rabbit killed in this study by the lethal effects of colchicine displayed the classical symptoms of colchicine poisoning: diarrhea, bloody stools, lethargy, and progressive paralysis appearing first at the caudal end and extending cephalad. Several of the rats displayed bloody nasal hemorrhages.

The hamsters showed no effects whatever. All animals that were tested proved fertile. No attempt was made to check against the possibility of a certain post-treatment period of infertility, but some animals were tested and proved fertile as early as 5 days and others as late as 37 days after treatment, and hence there is no reason to believe that any infertile period occurs. Moreover, there was a normal increase in weight of 1.5–15 g/animal from the time of injection to the termination of the experiment, 4–8 weeks later.

Another series of 6 male animals (2 rats, 2 hamsters, and 2 white mice) was fed a mixture of one third *Colchicum autumnale* seed,[2] containing not less than 4.5 mg colchicine/g of seed, mixed with two thirds pulverized Purina laboratory chow blocks, in order to determine if the seed, too, affects rats and mice and not hamsters. Five g of this was fed daily to each rat, 3 g daily to each hamster, and 2 g daily to each mouse. From the third day the amount of food for each animal was doubled in order to ensure an adequate nutritive supply. The animals were kept in individual cages with water dishes; one of each pair had shavings for bedding; the other cage was left bare. The food was placed on a paper on the floor of the cage.

TABLE 1

APPROXIMATE LENGTH OF SURVIVAL FOLLOWING VARYING DOSES OF COLCHICINE

Dosage (mg)	Mouse	Rabbit	Rat	Hamster
.12			Lives	Lives
.25			2 days, 14 hr	"
.50	5 days		24 hr	"
1.0	3 days, 21 hr	8 hr	21 "	"
1.5	24 hr		10 "	"
2	24 "		4–4.5 "	"
3	10 "			"
4	10 "			"
5–10				"

Both mice died on the 7th day of the experiment. One had dropped in weight from 24 to 20 g; the mouse with no bedding dropped from 24 to 15.6 g.

The rat in the bare cage had dropped from 112 g to 69.2 g by the 6th day, when it died. The other rat had dropped in weight from 99 to 68.3 g by the 9th day, when it was sacrificed. Diarrhea could of course account for part of the weight loss, but the second rat seemed to be starving voluntarily. Large amounts of uneaten food were present in both the rat cages.

The two hamsters gained 1.5 g and .6 g during the same period.

A control mouse, fed identical gram amounts of pure chow alone, rose in weight from 25.5 to 25.7 g at the end of 9 days.

The injection series definitely indicates that the hamster possesses a natural resistance to the usual toxic effects of colchicine, a resistance which far exceeds that of other laboratory animals. Poe and Johnson (*1*) report the lethal dose of colchicine in the rat to be 1 mg/kg body weight injected intraperitoneally, with death in 51 hr. Sollmann and Hanzlik (*2*) give 1 mg/kg body weight injected intramuscularly as the lethal dose for the dog and cat. The lethal dose in man is said to be variable, but is about 8 mg/kg body weight (*3, 4*).

[1] Postdoctoral fellow of the National Cancer Institute, National Institutes of Health, USPHS.

[2] Supplied through the courtesy of S. B. Penick & Co.

Perhaps no definite conclusions are justified by the colchicine feeding experiment, in view of the small number of animals used. It may well be that death in half the cases was from starvation rather than toxicity of the drug. However, the starvation must have been voluntary, since large amounts of food material were left untouched in the cage, and the duration of the experiment was not sufficient to suggest death from malnutrition.

The resistance to colchicine displayed by the hamster strongly resembles the natural resistance of the rabbit to aconite. In this respect, it is of interest to note that colchicine, which is usually extracted from the meadow saffron, *C. autumnale*, has also been isolated from other species of *Colchicum*. Although *C. autumnale* is distributed throughout Europe, the center of distribution for the genus (with 30 species) is in Asia Minor (*5*). This suggests that resistance in the hamster may have developed from close association with the plant in the natural habitat, *Colchicum* probably being used by the hamster as food. How high this resistance may extend, and what mechanism is involved, would be interesting to determine.

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The Turnover Time of Phosphorus in Normal, Sickle Cell Trait, and Sickle Cell Anemia Blood *in Vitro* as Measured with P^{32} [1, 2]

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The close relation between oxidation and phosphorylation in the living cell would lead one to expect that a disease which affects one would have some affect upon the other. Thus in sickle cell anemia, sickle cell trait, or sicklemia (henceforth called trait), and normal blood, a study of rate of uptake of phosphate by the red blood cell under various conditions should give insight into the mechanism of phosphorus transfer and its disturbance in this serious blood dyscrasia.

In order to obtain comparable data with some statistical reliability, we secured blood samples from 10 normal, 9 trait, and 7 sickle cell anemia patients. The sickle cell patients were known cases which had been treated on the Pediatric Service of Freedmen's Hospital for typical crises of the disease. Four slides were made of each patient in the study, using the methods of Singer and Robin (*1*) and Daland and Castle (*2*). All the anemia and trait patients showed sickling. None of the anemia patients had received blood transfusions in the three months preceding this study. The trait cases were siblings or parents of known sickle cell anemia patients. The normal cases were asymptomatic and, of course, showed no sickling. The age distribution of the subjects is given in Table 1.

TABLE 1

	Normal	Trait	Sickle cell anemia
Lowest	9 years	4 years	2 years
Highest	14 "	49 "	10 "
Average	10.5 "	23 "	9 "

Approximately 23 ml of blood was taken from each patient. On 3 ml a complete hemogram was done. Exactly 20 ml was mixed with 0.8 ml of the ammonium potassium oxalate solution (2 g potassium oxalate and 3 g ammonium oxalate in 100 ml solution), following the method of Taylor *et al.* (*3*). This solution caused no swelling of the erythrocytes. The blood samples were incubated in stoppered brown bottles with 13.7 ml air above the sample. To each sample of a group, 0.5 ml of isotonic NaCl containing a tracer amount of P^{32} as PO_4 in weak HCl was added (e.g., 0.54 mc in 0.5 ml solution to each sample of normal blood). The activities were checked against the Tracerlab simulated P^{32} source.

The blood samples were incubated for 4 hr at $38° \pm 0.1°$ C. There was no sickling in the blood samples during incubation. After incubation, total, acid-soluble, and inorganic phosphorus were determined, following the method of Fiske and Subbarow (*4*), on the whole blood, the plasma, and red blood cells. The radioactivity was determined on an aliquot of each sample, evaporated to dryness and counted with a mica end window Geiger-Müller tube, thickness 3 mg/cm², feeding into a Nuclear Instrument and Chemical Corporation Model 172 scaler.

Blood samples were centrifuged for 15 min at 3000 rpm to separate the plasma from the red blood cells. The plasma was drawn off as completely as possible. The cells were resuspended in isotonic saline, centrifuged, and the supernatant saline was drawn off and discarded. This washing was repeated. The red cells were then frozen at $-20°$ C to produce hemolysis and to prevent hydrolysis of the organic phosphorus compounds. For analysis the frozen cells were thawed and diluted with distilled water.

The results are expressed in specific activities defined as the counts/sec/mg of phosphorus corrected for radioactive decay (Table 2).

In this preliminary report we shall consider only

[1] Aided by Atomic Energy Commission, Project No. AT(30-1)-892.

[2] We wish to acknowledge with thanks the participation of Juliette M. Simmons, Louis Swaby, and Hugh Anderson in this work.

TABLE 2

Total phosphorus	Plasma		Red blood cells	
	mg/ml	SA*	mg/ml	SA
Normal (av of 10)	0.165	3.41	0.60	1.65
Trait (av of 9)	0.270	2.05	0.74	0.88
Sickle cell (av of 7)	0.160	1.60	0.93	0.39

* SA = specific activity as counts/sec/mg of P corrected for radioactive decay.

the total phosphorus. Qualitatively, the behavior of all other fractions was similar to that of the total phosphorus.

In this experiment, the important consideration is the rapidity with which equilibration of P^{32} is being reached between the plasma and the red blood cell (rbc). A measure of this equilibration is the ratio or the specific activity of the red blood cell to that of the plasma. Gourley and Gemmill (*5*) have shown that the uptake of P^{32} as phosphate by the red blood cells, at least during the initial period, follows a first order reaction. If we assume that the first order is an acceptable approximation over the 4-hr period, we have

$$\frac{\text{SA of rbc}}{\text{SA of plasma}} = (1 - e^{-\alpha t}).$$

Using the numerical values, we have α in hours^{-1} in Table 3.

Having the values of the α's, we may calculate the turnover times in the following manner. The factor $e^{-\alpha t}$ is the metabolizing function (*6*) for phosphorus in the red blood cell. Since the exchange of phosphorus (as phosphate) may be looked upon as an instance of dynamic equilibrium, we have for the amount of the normal phosphorus M(O), in the red blood cell (*7*),

$$M(O) = M(O)e^{-\alpha t} + \int_0^t R(\theta)e^{-\alpha(t-\theta)}d\theta.$$

The rate of entry, $R(t)$, determined from this equation is $M(O)\alpha$, where M(O) is the constant amount of phosphorus in mg/ml of red blood cells. With the numerical values from Table 2 for M(O), we have the rates given in the third column of Table 3.

The turnover time is defined as that interval during which the amount entering the cell equals the amount present, or (*7*)

$$M(O) = \int_0^\tau R(\theta)\, d\theta,$$

where τ would be the turnover time. From this equation, $\tau = \frac{1}{\alpha}$. The turnover times are given in Table 3.

TABLE 3

CHARACTERISTICS OF THE BLOOD SAMPLES

	SA of rbc / SA of plasma	α(in hr^{-1})	Rate of uptake in mg/ml of rbc/hr	Turnover time of P (hr)
Normal	0.48	0.160	0.096	6.3
Trait	0.43	0.140	0.103	7.1
Sickle	0.24	0.065	0.060	15.3

The turnover time of P in the sickle cell anemia red blood cell is, therefore, approximately 2½ times greater than that in the normal red blood cell under these experimental conditions. This large difference indicates that, whatever the basic malfunctioning system in sickle cell anemia (*8*), it reveals itself also as a marked reduction in the rate of turnover of total phosphorus in the red blood cell *in vitro*, in the presence of ammonium potassium oxalate. The turnover times for all phosphorus fractions so far examined have this relation: τ normal $< \tau$ trait $< \tau$ sickle cell.

These differences in turnover times cannot be attributed at present exclusively to differences in permeability of the red blood cell membrane or to reactions within the cell. They seem not to depend upon a difference in the surface/volume ratio, since the erythrocytes in the three groups did not differ significantly in size. Experiments are in progress which, it is hoped, will elucidate the specific mechanism of the phosphorus exchange which is altered in the trait and sickle cell cases.

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Control of Covered Smut of Wheat by Rapid Seed Treatment with an Antibiotic[1]

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In a previous paper (*1*), it was reported that covered smut of oats and covered smut of wheat, or bunt, were controlled in the field by seed treatment with the antibiotic actidione. The method of treatment used was not considered a practical one as it involved a prolonged soaking of the seed for 4 hr. Moreover, in the case of wheat, the results in bunt control were not too convincing, because of a low percentage of infected plants in the checks. They also were not very promising because of rather serious phytotoxicity expressed in seed injury. It was thought that the treatment might be modified in certain ways and in consequence made more practical. To this end, preliminary greenhouse experiments were made in the spring of 1951 with rapid treatments using actidione[2] in dust

[1] Financial assistance from the National Research Council of Canada is gratefully acknowledged.

[2] Kindly supplied by the Upjohn Company of Kalamazoo, Mich., through the courtesy of J. H. Ford.

and liquid form. The main results are briefly reported here.

The seed used in the experiments was a sample of spring wheat naturally contaminated with spores of *Tilletia* spp., which cause covered smut of wheat. It was further artificially contaminated by the addition of 0.5 g of similar spores to each 100 g of seed. Portions of the infested seed were treated with different amounts of actidione dusts consisting of mixtures of a finely powdered clay and the antibiotic in one type of treatment, and with actidione diluted with a 0.02% aerosol and water mixture in another. Three types of checks were included: one untreated, one to which the clay dust only was applied, and one which was immersed for 1 min in a 0.02% aerosol and water mixture. The seed was treated one day and sown the next. Four replicates (100 seeds/replicate) of each treatment and each check were sown in randomized rows in a bed of black soil in the greenhouse. The most important results are presented in Table 1.

TABLE 1

EFFECT OF RAPID SEED TREATMENTS WITH ACTIDIONE ON THE EMERGENCE OF SPRING WHEAT AND ON ITS INFECTION BY SEED-BORNE COVERED SMUT FUNGI

Treatment	Concentration and form	Amount or time	Av % emergence	Av % smutted heads
Actidione	.5% dust	½ oz/bu	85.0	0.0
"	.5% "	1 " "	85.0	.0
"	1.0% "	½ " "	84.5	.6
"	1.0% "	1 " "	73.0	.0
"	10 ppm liquid	1 min	84.0	0.0
Clay diluent (ck)	Dust	1 oz	91.3	6.1
Aerosol-water (ck)	Liquid	1 min	91.3	8.3
None (ck)			90.7	22.9
LSD			7.9	

The above results of greenhouse experiments show that rapid seed treatment of wheat with actidione in both dust and liquid form gave complete or almost complete control of covered smut of wheat. Emergence appeared to be reduced slightly, but the reduction was significant from the emergence of the checks only with the highest dosage of the antibiotic in dust form. The entire effect in smut control cannot be attributed to the antibiotic, since it is evident from the check results that the diluents had considerable influence themselves in reducing the severity of the smut infection. This, however, may be considered an advantage of the treatments, especially in view of the fact that the diluents had no injurious effects on the seed. It will be noted that control of covered smut of wheat was obtained with actidione in highly diluted form and that the procedures followed in applying it were similar to those at present used in the treatment of wheat and other grains with standard fungicides. Moreover, field data which will soon be available tend to confirm in large measure the results of the greenhouse experiments given here. These will be reported in another paper.

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An Improved Method for Measuring Coagulation Time

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Numerous methods for measuring the clotting time of blood have been proposed. The most satisfactory technique for the purpose, however, is the so-called Lee and White method (*1*). This consists in withdrawing blood from a vein, or in smaller animals directly from the heart, introducing 1 or 2 ml of the blood into flat-bottomed glass shells or homeopathic vials, and measuring the time it takes for the blood to clot as indicated by tilting the tubes every minute until the blood no longer flows.

We have recently devised an improvement in the Lee and White technique which we find very useful for careful research investigations. This consists in the employment of an instrument that enables the investigator to measure accurately the exact angle at which the surface film of the whole blood in the homeopathic vial is broken and begins to flow. The apparatus, which is made of plexiglass, consists of a vertical quadrant fixed on a plastic base (Fig. 1). At the center of the quadrant there is attached a radial pointer which carries at its base a small platform on which the vial containing the blood is placed. The quadrant is subdivided into degrees and half-degrees from 0 when the pointer is in a vertical position to 90° when it is in a horizontal position.

Blood is obtained from rabbits by direct cardiopuncture and immediately transferred to flat-bottomed vials 15 mm in diam and 45 mm in height. As soon as 1 or 2 ml of the blood is introduced into the perfectly clean vial the experimenter notes the posi-

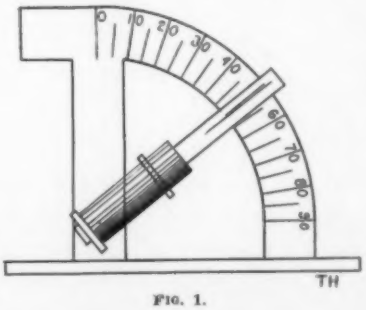

FIG. 1.

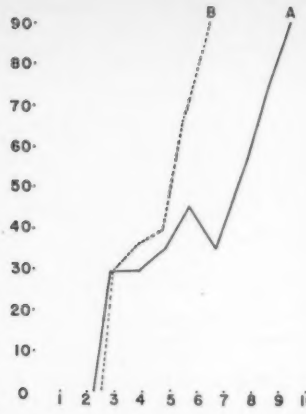

FIG. 2. Experiment on rabbit weighing 2.5 kg. Horizontal line indicates time in min; vertical line indicates angles at which blood surface film is broken. *A*, Normal clotting time, 10 min; *B*, 2 hr after parenteral injection of 2 mg diacetylmorphine; clotting time, 6 min. Note dip in normal curve after 6 min.

tion of the pointer in degrees of the quadrant every minute until the blood is completely clotted. That end point occurs when the radial pointer is in a horizontal position—in other words, at 90°.

It was found when using this instrument that the clotting process does not always proceed in a progressive manner. There are points when the film does not break so quickly, followed by a less resistant surface film. This is quite characteristic of normal blood. Furthermore, we found that the curve representing coagulation angles in relation to clotting times will vary with the thromboplastic or anticoagulating agents employed (Figs. 2, 3). This may eventually prove to be useful in analyzing the clotting mechanism after various drugs. For example, this instrument is

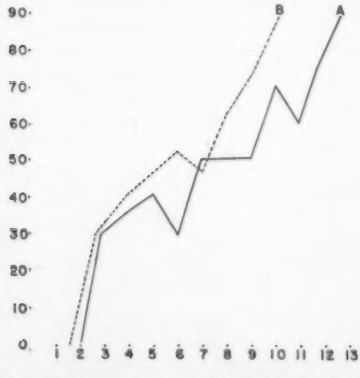

FIG. 3. Experiment on rabbit weighing 3.4 kg. Horizontal line indicates time in min; vertical line indicates angles at which blood surface film is broken. *A*, Normal clotting time, 13 min; *B*, 2 hr after injection of aureomycin; clotting time, 9.5 min. Note dips in normal curve after 6 and 11 min, and 1 dip in other curve after 7 min.

useful in following the effects of heparin when used to determine the imbalance of coagulating and anticoagulating factors in the blood (*2*); also the thromboplastic properties of penicillin (*3, 4*), mercurial diuretics (*5*), amphetamin (*6*), and other drugs.

The advantages of the above-described apparatus are obvious. We eliminate the personal equation involved in picking up the vial and tilting it at no precise angle, as well as shaking the specimen, all of which manipulations may produce appreciable variations in readings. In other words, this method enables the investigator to measure the clotting time more exactly and, at the same time, by plotting the relation curve between clotting time and clotting angle, it is helpful in analyzing the mechanism of the clotting process.

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The Action of Ultraviolet Light on the Pentose Moiety of Nucleic Acids and Related Compounds[1]

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In the present work, the fate of the pentose moiety of nucleotides upon exposure to ultraviolet radiations was investigated. The fact that free carbohydrates undergo complex changes when subjected to ultraviolet light was verified in preliminary studies, in which 2×10^{-4} *M* solutions of glucose and ribose, buffered with phosphate at pH 7.4, were placed in 1-cm rectangular quartz cells and exposed to radiations from an unscreened quartz lamp at a distance of 5 cm from the center of the lamp. Within 60 min both sugars were rendered incapable of reducing the alkaline copper salt reagent of Benedict (*1*) and of giving a positive Molisch test. In addition, the irradiated ribose solution did not react to the *p*-bromoaniline acetate test (*2*), which depends upon the formation of furfural from free pentoses.

In similar experiments with dilute solutions (30 μg/ml) of adenylic acid, cytidylic acid, and yeast nucleic acid, the compounds lost the ability to form furfural within an exposure period of less than 90 min. Both unexposed and irradiated solutions were assayed for furfural-yielding capacity by a modified Reeves and Munro technique (*3*). Moreover, irradiated

[1] Aided, in part, by an Institutional Grant, American Cancer Society, Inc.

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TABLE 1

CHANGES IN FREE AND COMBINED CARBOHYDRATE SOLUTIONS (pH 7.4) DURING EXPOSURE TO ULTRAVIOLET RADIATIONS

Change	Compounds showing change
1. Loss of reducing properties	Glucose, ribose
2. Loss of ability to give a Molisch test	" "
3. Loss of ability to give a *p*-bromoaniline acetate test	Ribose
4. Loss of furfural-yielding capacity	Ribose, adenylic acid, cytidylic acid, yeast nucleic acid
5. Loss of ability to give a Stumpf test	Sodium thymonucleate

solutions of sodium thymonucleate failed to react to the Stumpf test (*4*) for desoxypentosyl purines.

The foregoing data, summarized in Table 1, demonstrate that both free and nucleotide-bound carbohydrates are readily destroyed by ultraviolet light. These results supplement, therefore, previously known viscometric and ultraviolet spectrophotometric findings (*5–7*), indicating that the compounds undergo an extensive over-all photodecomposition.

Finally, a limited study was made of the protection of various compounds on free and on nucleotide-ribose. As gauged by furfural production (*3*), the pentose breakdown was appreciably inhibited in the presence of 1% solutions of thiourea, sodium thioglycolate, acetic acid, sodium acetate, or oxalic acid. The most effective inhibitor was composed of 1% thiourea dissolved in 1% acetic acid. Solutions of ribose, adenylic acid, or cytidylic acid in this medium showed essentially no decrease in furfural-yielding capacity, even after 4 hr exposure to ultraviolet raditions. In contrast, 1% trichloroacetic acid or perchloric acid offered essentially no protection.

No attempt was made in the present study to find optimum conditions, since results will vary quantitatively with differences in the dilutions and dosages, the composition and size and shape of containers used, the wavelength of radiation, etc.

Although there is to date no crucial proof that nucleotide destruction is involved in the damaging effects of ionizing radiations upon living protoplasm, the possibility exists that some such phenomena as described here are factors in the questions of radiation lethality and of the mechanisms of some agents in reducing radiation mortality.

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Plastics in Trace Element Research

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Water culture methods of growing plants were known as early as 1860, when J. Sachs (*1*) and W. Knop (*2*) independently grew plants in nutrient solutions containing the "essential" elements, N, S, P, K, Ca, Mg, and Fe. It was not until approximately two decades ago, however, that studies of culture solutions indicated the important role played by trace elements in the physiological functions of plants.

Trace element studies invariably pose a problem because of contamination. Purification methods have advanced to the point where contamination from the nutrient solution itself is secondary to that introduced from other sources, including the containers. In general, workers using nutrient solution methods advocate the use of Pyrex glass for containers in experiments other than with boron. However, expense and chance of breakage are limiting factors.

As plastics are relatively cheap and have several obvious advantages over glass, it was decided to test some of them for possible contamination caused by Cu, Mn, Zn, or Fe. Several small plastic refrigerator jars, $4'' \times 4'' \times 3''$, plastic cookie jars, $6'' \times 6'' \times 7''$, and a large plastic tote box reinforced with glass threads, $24'' \times 28'' \times 6''$, were cleaned thoroughly in a sulfuric-dichromate solution, after which they were rinsed first with water, then with 2% HCl, and finally with water, double-distilled through Pyrex. They were then filled with a known quantity of a slightly acid, Pyrex double-distilled water, covered, and set aside in the laboratory for 2 weeks. At the end of this period the water was transferred to clean Pyrex flasks and evaporated almost to dryness. After the samples were diluted to a known volume, an aliquot was taken and analyzed for Cu, Zn, Mn, and Fe. These analyses were run in triplicate. In no case was there any contamination from the containers. Tests were not made for boron or molybdenum, but the composition of the plastic should make the containers suitable for research on these elements also.

The small refrigerator jars were subsequently used for studies of the effect of copper on the susceptibility of the Scotia bean to tobacco mosaic virus. A small hole was made in the lid by means of a hot metal bore. The plants were germinated in Petri dishes and at an early stage were threaded through the hole in the lid so that the roots were immersed in the nutrient solution and the leaves extended above the dish. The stem was supported by cotton at the point where it passed through the lid. As the stem enlarged, the cotton was removed. The same technique was used with the cookie jars in copper-deficiency experiments. The tote box, however, does not have a lid and presents a different problem. Support of the plants was provided by stretching a plastic gauze over the top of the box. The plants were threaded through the gauze,

which is flexible enough to allow for growth of the stems. Plastic tubing may be used to set up a drainage system for the tote box. In order to simulate soil conditions and provide better support for the root system of the plant, plastic beads or debris may be used in the bottom of the box.

The expanding plastics industry has placed an infinite number of containers, dispensers, tubing, and analytical equipment on the market. These items can easily be adapted for trace element studies. Plastics, indeed, can provide an answer to the ever-present question of expense and practicality.

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Microradiography of Microfossils with X-Ray Diffraction Equipment[1]

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Several articles have appeared recently presenting different techniques of microradiography and showing their value in the study of thin sections, primarily of biological and medical material (*1, 2*). This method is valuable in the study of whole specimens as well as thin sections, as will be shown by the results with paleontological material (*3*).

Calcareous, siliceous, and pyritic microfossils of varying size and thickness were radiographed with x-ray diffraction equipment. The internal arrangement of foraminiferal chambers and of muscle-scar patterns of Ostracoda, and the presence or absence of pores in shells of both groups were detected where preservation was favorable—sometimes when no other method had been successful. Furthermore, no harm was done to the specimens.

The type of x-ray diffraction apparatus used is available in crystallographic laboratories and mineralogical departments of many institutions. This apparatus usually has 4 windows through which x-rays are transmitted into special cameras. The removal of one of these cameras makes it possible to utilize the x-rays for microradiography without any modification of the apparatus itself. The radiation is directed approximately horizontally in the equipment used (North American Philips), so that it is necessary to mount specimens and photographic plate vertically. A simple stand can be used, placing the glass photographic plate in a holder, with the specimen supported in front of it. Precautions must be taken to guard the operator from exposure to x-rays.

Diffraction apparatus has interchangeable tubes with targets of any one of several metals, permitting essentially monochromatic radiation of any one of several wavelengths between 0.6 and 2.3 A. The radiation in all cases is long wavelength, or soft, which is favorable for detecting the thin delicate structures that would not be seen if short or hard rays were used. No filter was used in this work.

[1] Publication authorized by the Director, U. S. Geological Survey.

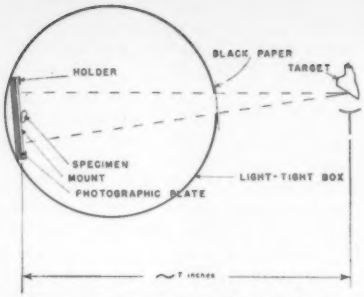

Fig. 1. Diagrammatic sketch of holder.

For microfossil specimens averaging about 0.5 mm or less in thickness, the factors, with a copper target tube, were 25–35 kv (rarely 45 kv), 15–20 ma, and 5–20 min. Time and voltage are the variables, the values depending on the size and chemical composition of the material. Distance from the target to the film is approximately 7 in., which gives a large enough beam of x-rays to cover the specimens.

To support the specimens and photographic plate, a diffraction camera was adapted by fitting a holder for the plate and specimen in the camera, opposite an opening transparent to x-rays (Fig. 1). Any light-tight box with such an opening may be used. The opening is placed directly against the x-ray window. This setup permits close contact between specimen and emulsion, thus lessening blurring (*4*). It is also easy to center the setup rapidly for each exposure.

The microfossils are mounted with gum tragacanth on cleared x-ray film, both of which are transparent to x-rays. The cleared film provides a firm support for the specimens, which can easily be placed in any position for microradiography. Eastman 548-O spectroscopic plates (an extremely fine-grained emulsion)

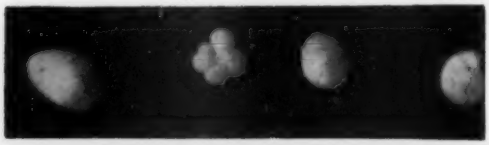

Fig. 2. Photograph of group of Foraminifera. Approx. × 36.

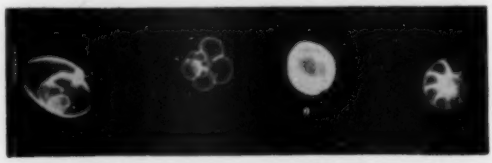

Fig. 3. Microradiograph of same Foraminifera, showing arrangement of chambers. Approx. × 36.

were used. These glass photographic plates are cut to fit the holder, and the mounted specimen and plate are placed in the holder in the darkroom. The photographic plates were developed in D-11, D-19, or DK-50. For the maximum enlargement desired (less than 100 times) all these developers were satisfactory.

Although stereoscopic microradiographs have not been made by the author, they could easily be taken, particularly if the setup permits mounting the specimens horizontally rather than vertically (*5*).

Figs. 2 and 3 are, respectively, a photograph and a microradiograph of a group of Foraminifera. The internal arrangement of chambers is plainly visible in the microradiograph.

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The Use of an Ion Exchange Resin for the Hydrolysis of Casein and Coffee Proteins

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A study of the noncaffeine nitrogenous constituents of coffee has led to an investigation of the amino acids present in coffee proteins. The method used initially was the classical hydrochloric acid hydrolysis followed by chromatographic separation of the amino acids on a column of 200–400 mesh Dowex-50,[2] patterned after the technique of Moore and Stein (*1*). Since there was the customary humin formation during hydrolysis, other methods were sought.

It has been observed (*2, 3*) that insoluble cation exchange resins in the hydrogen form act as catalysts for certain hydrolytic reactions, such as ester hydrolysis and sucrose inversion. Dowex-50, a sulfonated styrene resin, behaves as an insoluble strong acid in aqueous solutions, and it was believed that it might furnish sufficient hydrogen ions to accomplish the hydrolysis of proteins. The fact that the resin removes most of the amino acids from the solution as they are formed would also be expected to favor the hydrolysis. Casein was selected for exploratory experiments. Accordingly, 3 g casein, 15 g 200–400 mesh Dowex-50, and 300 ml water were mixed thoroughly and refluxed. The solution gave a negative biuret reaction after about 70 hr. Boiling was continued for an additional 24 hr to insure completion of the reaction. At the end of the hydrolysis, most of the amino acids were on the resin. By using barium hydroxide, all the amino acids were stripped from the resin. This barium hydroxide extract was then treated with sulfuric acid to remove the barium and to give essentially a solution of amino acids. The amino acids also may be fractionally removed by use of HCl or various buffers. The same procedure was found satisfactory for the hydrolysis of proteins from a sample of green Santos coffee.

TABLE 1

Analyses of Coffee Protein Hydrolysates Prepared Using Hydrochloric Acid and Ion Exchange Resin

	Milligrams of nitrogen	
	HCl hydrolysate	Resin hydrolysate
Alanine	2.86	2.74
Aspartic acid	5.12	4.93
Glutamic acid	8.74	1.97
Leucine	5.58	5.44
Phenylalanine	2.06	2.07
Serine	1.56	1.46
Threonine	0.95	0.94
Valine	2.57	2.39
Basic amino acids and humin	15.39	14.70
Ammonia	4.89	4.50
Total recovered	54.25	45.52
Total in hydrolysate	61.60	61.60

The protein fraction of the coffee was prepared by water extraction of the ground green coffee. HCl was added to precipitate the protein. The precipitate was washed with water, then alcohol and ether, and finally dried. The HCl hydrolysate of this protein was prepared by refluxing 400 mg protein with 8 ml 6 *N* HCl on an oil bath at 135° C for 12 hr. After hydrolysis, the excess HCl was removed by distillation *in vacuo*.

The Dowex-50 hydrolysate was prepared from 400 mg of the protein by the method indicated above, using 40 ml water and 2 g of the resin. The amino acids were removed from the resin by the use of barium hydroxide. This hydrolysate was nearly clear in contrast to the dark, humin-containing solution obtained by carrying out the hydrolysis with HCl. It has been suggested (*1*) that the amount of humin produced in an acid hydrolysate of a protein can be held to a minimum by use of a large excess of acid. To be certain that the low humin formation in the resin hydrolysate was not due to the excess of liquid phase present, another portion of the protein was hydrolyzed for 12 hr with 200 times its weight of 6 *N* HCl. This procedure did appear to decrease humin formation somewhat, but the hydrolysate still became very dark and some insoluble humin was produced.

Both the HCl and resin hydrolysates were chromatographed on Dowex-50, using a column 110 × 1.5 cm. The amino acids were fractionally eluted from the column, using acetate buffers. The buffers were put through the column by the use of nitrogen gas under a pressure of 200 mm Hg. The individual fractions

[1] The authors are grateful for assistance in this investigation by a grant-in-aid made by the Nestlé Company through the Ohio State University Development Fund.

[2] Obtained from the Dow Chemical Company, Midland, Mich.

were analyzed by measuring the intensity of the blue color produced upon heating with ninhydrin solution (*4*). Ammonia nitrogen was determined by the classical aeration procedure. The use of barium hydroxide for removing the amino acids from the resin would probably cause large losses of any ammonia present; therefore, the ammonia nitrogen of the resin hydrolysate was determined by aerating a hydrolysate in which the amino acids were removed from the resin by use of hydrochloric acid rather than barium hydroxide. Basic amino acids plus humin were determined by phosphotungstic acid precipitation followed by Kjeldahl determination for nitrogen.

The analyses of the two hydrolysates are shown in Table 1.

By using the method of Graham *et al.* (*5*), the tryptophan content of the coffee protein was found to be 1.7%, thus accounting for an additional 0.93 mg of nitrogen in Table 1. Tryptophan is destroyed by acid hydrolysis or by refluxing with distilled water; hence it was not found in either hydrolysate. No hydroxy proline was found using the method of Newman and Logan (*6*). Using paper chromatography techniques, only a trace of tyrosine was detected, and arginine, histidine, and lysine were shown to be present.

It may be observed from Table 1 that ammonia nitrogen is slightly higher for the HCl hydrolysate, indicating perhaps more degradation or deamination in this procedure. Furthermore, a notably low glutamic acid value was obtained in the resin hydrolysate, and some of the others tend to be slightly low when compared with the HCl hydrolysate. It is probable that the glutamic acid in the resin hydrolysate formed pyrrolidone carboxylic acid (*7*). This acid might tend to form salts with the other amino acids and thus interfere with the chromatographic separation. That the low value of glutamic acid in the resin hydrolysate was due to pyrrolidone carboxylic acid formation is borne out by the fact that upon treatment with HCl, glutamic acid appeared in the resin hydrolysates in an amount comparable to that found in the original HCl hydrolysate.

Using commercially available vitamin-free casein, resin hydrolysates have been prepared by the above method. On evaporation, a crystalline, almost white product is obtained. This material readily dissolves in water and will serve as the sole source of nutrients for many microorganisms at 0.5% level. The resin hydrolysis of casein may be hastened by the use of a small amount of HCl. For example, 6 g casein, 30 g Dowex-50, and 600 ml 0.05 *N* HCl, or 60 g casein, 300 g Dowex-50, and 1700 ml 0.1 *N* HCl, show no biuret reaction after 48 hr.

The method of hydrolyzing proteins by the use of ion exchange resins shows considerable promise as a technique in the study of proteins. Recent studies using casein have shown that there may be some simple peptides present in the resin hydrolysates; however, indications are that the method gives nearly complete hydrolysis of the proteins studied. Work is continuing on the characterization of other proteins and the optimum conditions for carrying out hydrolyses using Dowex-50 and other resins.

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Comments and Communications

Teacher Training

In the United States as a whole far too little attention is given to training teachers of science. This is true of the teachers in the grades who must conduct science study periods, of "general science" teachers in junior high schools, and of teachers of physical and biological science in high schools.

This communication is not a plea for more national committees to prepare more excellent reports, which will be studied by too few of the right people and which will probably be acted on by almost no one; rather, it is a plea for the scientists in each college and university to act now. Fortunately, there are appropriate actions that can be taken and that will not entail great expense.

Relatively few of our colleges and universities have adequate teacher-training programs that provide *suitable* courses in science. The usual beginning course in a natural science is almost certain to be aimed at the production of more specialists in that science. To get a broad training in science, the prospective teacher would have to complete at least 30–50 semester hours of such first-year college courses. In addition, the teacher of senior high-school science should specialize in the particular science he or she plans to teach.

To expect such extensive training of our public school teachers is entirely unrealistic. The relatively low salary scales have attracted an entirely inadequate supply of students into teacher-training programs. The immediate problem that needs our attention is how to provide training in science for students who are now preparing to become grade and high-school teachers. This problem may be broken down into two

different questions: How can we provide broad science training for the prospective grade school teacher? and How can we provide training for the prospective high-school teacher who may teach both "general science" and a specialized senior high-school science? The standard first-year college courses in the fundamental sciences have not been sufficiently successful in providing the requisite training.

In meeting their responsibilities to society university scientists have three continuing duties: (1) As students they must continue to increase their knowledge of science; (2) as research workers they must advance science and make practical applications of it; and (3) as teachers they must transmit science to the next generation and train future teachers of science. The first duty need not be discussed here. Unfortunately, all too often the second is given so much emphasis that the third is almost entirely neglected. And this attitude often evolves from the practical point of view taken by the scientist—he emphasizes those activities he believes the university administration considers most valuable when awarding increases in rank and salary.

Actually duties No. 2 and No. 3 are of equal importance to society. To argue otherwise would be like arguing that, for the production of power by a steam engine, the water in the boiler is more important than the fire under it. Duty No. 3 involves research in the methods of, and on apparatus for, transmitting science to future generations. The scientists in each major branch of science must take an active, vigorous part in the solution of the problem of training its teachers and of developing its teaching methods and equipment. This must be done for our public schools, as well as for our colleges and universities.

It is important, therefore, that each fundamental science department have on its staff at least one high-ranking member who devotes his time to the study of teacher-training problems, to research in methods of, and apparatus for, instruction, and to the communication of his findings to future teachers of science.

Society is demanding that our school children receive some instruction in science in every grade from one through nine. The director of elementary education in the New York State Department of Education has stated, "Next to reading, science is the most important subject." Since only a fraction of the children who complete high school ever go to college, it is essential that several courses in biological and physical science be offered for senior high-school students, and this cannot be done without teachers trained in science. We scientists, in our respective colleges, must plan and offer *suitable* courses in science for public school teachers at appropriate levels of difficulty and completeness. In addition, appropriate courses in the methods of presenting science subject matter and of obtaining and using the necessary teaching materials must be organized and taught on a cooperative basis by *suitable* staff members in the science departments.

The plight of physics in the high schools of the U. S. today is indicated by the recent change in the rules governing admission to the U. S. Naval Academy—training in physics is no longer required. Without doubt this admittedly undesirable change was made because so few high-school students have an opportunity to study physics. One of the most important causes of the scarcity of physics courses has been the lack of available teachers. Public school officials have not been able to find persons with even a bare minimum of proper training to teach the subject, because the number of physics graduates is rather small and industry has been able to monopolize the supply by offering much higher monthly salaries for all twelve months of the year.

Perhaps physicists and chemists should take their cue from botanists and zoologists, and assist in the adoption of a recognized course in "general physical science" for the high schools, corresponding to the usual course in "biology." Why should the college physicists and chemists not encourage such a move? It is not a question of physics (or chemistry) *or* "general physical science;" rather, it is a question of "general physical science" or no course at all in any physical science in senior high school. Such a general physical science course would be somewhat less advanced than either a physics or a chemistry course; it would require less expensive apparatus, and it could be taught successfully by a teacher who has had somewhat less specialized training in physics or chemistry. In the large high schools students could even be given a choice of "general physical science" and physics and/or chemistry.

It is useless for scientists to stand on the side lines and criticize present grade- and high-school science teaching, or the lack of it, without making concrete, *practical* suggestions for improvements, and without making such changes in our college offerings, entrance requirements, and degree requirements as are necessary to achieve the ends in view. In planning action we must remember that the high school is not primarily a college preparatory school; only a fraction of its students enter college. We must also remember that all children below a certain age *must* attend school; this is the law of the land, and it prohibits flunking the lower third of the children out of school. And, most important of all, we must not forget that all of them will soon be voters.

Compulsory school attendance brings into the upper grades and into high school children with a tremendous range of native abilities. A recent Associated Press story quoted Arthur S. Adams, president of the American Council on Education, as saying that a score of 70 on the new Selective Service aptitude test will be made by "only about one sixth of the general population, or about half of the college freshmen." Thus, in comparison with public school pupils, college freshmen are, on the average, a very able group of people. These facts must be kept in mind when a practical course of action for improving science teaching in the public schools is being planned.

Providing teachers who have had appropriate training in science for our grade and high schools will

require the cooperation of college science departments, departments of education, and the state agencies that certify the teachers. I believe that our state departments of education and our colleges of education will be more than pleased to have the cooperative assistance of the scientists of our colleges and universities, in their attempt to improve elementary and secondary instruction in science. We scientists should find out just how we can assist in bringing about this desirable result, each in his own locality. Let us exercise a spirit of research and base our actions on the facts which the public school teachers and administrators will be only too glad to supply. Improvement cannot go far until teachers with appropriate training are available.

If science is to receive adequate attention in our educational structure, it must receive the general support of the voters, including especially our state and local lawmakers and officials. Adequate support is not likely to be obtained until citizens have much more information about science than they have at present. This, in turn, is not likely to be achieved until science is taught by reasonably competent teachers throughout our elementary schools and high schools. Is it not a most important proper function of college scientists to supply appropriate courses in science for prospective public school teachers? Why not attack the problem immediately in your own college?

WILLIAM SCHRIEVER

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University of Oklahoma

Age of Folsom Man

IN 1950 a Texas Memorial Museum party made excavations in valley fill near Lubbock, Texas, where five superimposed, fossiliferous, late Quaternary strata are present. From the next to oldest of these strata, a diatomite horizon, charred bison bones were obtained and submitted to the Institute for Nuclear Studies, University of Chicago. The radiocarbon test on the charred bones gave an age determination of 9,883 ± 350 years (Libby, letter of Dec. 8, 1950). Excavations at the locality were continued during the summer of 1951, when additional occurrences of burned bones were observed in the diatomite horizon, and in this deposit also were found four Folsom projectile points, one small scraper, and numerous flint chips. Of the projectile points, two were complete and two broken. Each of the four points showed distinctive Folsom fluting. The upper and lower boundaries of the diatomite horizon are definitely marked, and there is no question but that the Folsom artifacts and the charred bones are in the same horizon in the section and are of the same age, proving that Folsom man hunted the bison at this place about 10,000 years ago.

From a gray sand stratum next underlying the diatomite, one artifact was found, a combined scraper and graver, or a scraper subsequently reworked as a graver. This older artifact may represent a culture older than Folsom, which has been found at a similar position in the section in the Clovis-Portales area in New Mexico. The excavations at the Lubbock and Portales localities were carried on under direction of Glen L. Evans. The conditions in New Mexico were briefly reported by the writer at the 1950 meeting of the Geological Society of America (*Bull. Geol. Soc. Am.*, **61**, 1501 [1950]).

E. H. SELLARDS

Texas Memorial Museum
Austin

Selective Application of Selective Herbicides in the Study of Vegetation Development

THE successional stages in the development of vegetation have been one of the chief—and most fruitful—fields of inquiry for American plant ecologists. Changes of vegetation with time, as on abandoned agricultural lands and sites subject to natural catastrophes, and the spatial belting of plant communities in bogs and swamps, have provided basic data for the formulation of hypotheses and theories that are now firmly—perhaps too firmly—entrenched in our thinking.

The study of this aspect of vegetation development has been furthered primarily by the use of permanent charted quadrats that are periodically checked, and by the assumption, sometimes but not always valid, that communities of different growth forms—as grasses, shrubs, and trees—are necessarily related to one another in a temporal sequence, especially when they occur in parallel belts, as along seacoasts and riverbanks.

The study of vegetation development on abandoned agricultural lands at Aton Forest, Litchfield Co., Conn., dates from observations and photographic records of 1927. It early became evident that "plant succession," although apparently normal for the Northeast, was not progressing in the conventional manner. For a period of six years, 1946–51, the selective application of selective herbicides, applied intensively to a total of 40 acres, has been yielding results of considerable interest. In view of the fact that, so far as the author is aware, others are not using herbicides for this purpose, this note is presented to stimulate basic research elsewhere.

The most critical phenomenon in any succession of plant communities is that of "invasion," involving migration of the propagule, germination, and successful establishment of the young plant. Too often the stage of invasion of a species has been assumed by its physiognomy. Thus, trees are assumed to have invaded shrubs when both are found together; and shrubs to have invaded grass when together. An alternative working hypothesis is that species of diverse growth form may have invaded a particular site at the *same* time, and that the present mixed communities may be the result of differential height growth, and of fortuities in the distribution of individuals. Evidence pro or con can be obtained by carefully removing all the individuals of selected species,

with observations on subsequent *re*invasion. The only technique available in earlier years was physical removal with shovel, mattock, or axe. The procedure was a failure in that pieces of rhizomatous or root-suckering plants were invariably left in the soil, new seeds were planted, bare inorganic soil was exposed, and the plant community ceased to be the one originally under investigation.

Herbicides now afford a "tool" of extreme value in this field of research. Various formulations of 2,4-D (2,4-dichlorophenoxyacetic acid) and 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) are available commercially. Most broad-leaved and coniferous plants are sensitive to them; grasses, ferns, and certain rhizomatous plants are resistant. With a knapsack sprayer equipped with a nozzle of low output, or using an oil-can, squirt gun, paintbrush, or one's fingers, a high degree of selectivity in application can be effected. Even with a knapsack sprayer one can basal-spray a tree or bush, and leave unharmed a plant 6 in. away. The chemicals are organic compounds that disintegrate in the soil in a matter of weeks or months, leaving no known residue. In the six years of application at Norfolk, no cumulative adverse effect has yet been noticed in the treated vegetation. In short, the selective application of selective herbicides allows one to pin-point out all individuals of most unwanted species, with apparently no ultimate physical or chemical changes in the soil, and with the rest of the plant community undisturbed.

Evidence now available from the author's study of vegetation development with the use of chemicals is sufficiently unprecedented to merit tests of this technique by others. For example, following local elimination of over 100 species of plants, reinvasion is resulting in a subsequent development totally different from that anticipated. Among the 70 kinds of woody plants eliminated, fewer than five give any evidence of staging a significant comeback even in the more open of the covers, and those five are returning in different proportions than they originally held. The significance of these phenomena for forest, range, wildlife, and other aspects of land management is worth critical consideration. They open up new vistas for research and development on the conversion to, and low-cost maintenance of, plant communities of all kinds, including those that are critical in the conservation of our natural resources.

FRANK E. EGLER
American Museum of Natural History

Book Reviews

Laboratory Design. National Research Council Report on Design, Construction and Equipment of Laboratories. H. S. Coleman, Ed. New York: Reinhold, 1951. 393 pp. $12.00.

If Stone Age man were to sit in judgment on our twentieth-century civilization, he might well be confounded by the seemingly endless operations involved in picking up the rock and hurling it at the charging beast—and, after the felling of the critter, by the long sequence of doings that delayed the meal. But, regarded in terms of result, this magic that is science would no doubt capture his imagination and command his attention.

There is no doubt about the wholesome respect for value that has directed the National Research Council and Mr. Coleman to so commendable an effort as publication of *Laboratory Design*—not to mention the research activity that forms the basis for the volume. Not only is there evidence of far-ranging and careful application to detail; there are clear signs of constant attempt at integration. In a field of endeavor that stretches so wide and deep, such fruitful means as the economical module of laboratory space and the standardized components of equipment are valuable contributions. These devices and yardsticks, born of the urgencies of science, attest to the concert of action and indicate a concern for end product. In this propitious climate, it would nevertheless seem appropriate for architect Roland Wank to warn, *as he does* in his introduction, against possible overconcurrence—and to speak for new approach when change and new discovery have reduced old systems to irrelevance. Perhaps, however, neither Mr. Wank nor the other contributors have placed enough stress on the role of the architect. Or perhaps there have been enough words; however, the majority of the buildings shown tell a story of arbitrary limitation. Meaningless bilateral symmetry, forced façade, insipid ornamentation, stand in the way of full realization. The factor of environment has been neglected. There has been but little brought forth that illustrates atmospheric quality of a space. There seems to be scant awareness of the need for the pleasant and the inspiring; little regard for the welfare of these humans who work for the general welfare. But these are the faults of the architects. They are the ones whom vision must lead to a deeper comprehension for this synthesis. This volume could have benefited from a more judicious selection of architecture.

Presentation is designed for easy reference—a refreshing change from the majority of factual publications. However, the book does not rise to the possibilities inherent in so colorful a realm. Where is there reflected the daring, the adventure, the beauty, of precise circumstance? Why should not typography, photograph, word, and drawing reveal the potencies and dignities of science? This failing seems to be part of a pattern of behavior that endures life in a medium-

gray, average, inanimate normality. Basically, nature is not that way, and scientists are the ones equipped to tell us so. Or is the higher evaluation the prerogative of the poet?

There would seem to be little doubt as to the immense value of this volume to all members of the laboratory team. It would appear to stand as a model, for other fields as well, in its systematic attack upon the common problem of fact-gathering and recommendation.

CHESTER NAGEL

The Architects Collaborative
Cambridge, Massachusetts

Cybernetics: Circular Causal and Feedback Mechanisms in Biological and Social Systems. Transactions of the Seventh Conference, March 23–24, 1950, New York. Heinz von Foerster, Ed. New York: Josiah Macy, Jr. Foundation, 1951. 251 pp. $3.50.

This new volume has been edited by Heinz von Foerster, of the Department of Electrical Engineering, University of Illinois, with the assistance of Margaret Mead, of the American Museum of Natural History, and Hans Lukas Teuber, Department of Neurology, New York University College of Medicine. This diversity of professional interests of the editors is indicative of the variety of professions represented by the conference participants and guests. The program is represented as an experiment in an attempt to reintegrate science. In the words of Frank Fremont-Smith, medical director of the foundation,

> . . . between the disciplines there are real difficulties in communication—partly emotional and partly semantic. Emotionally some investigators accept only data derived from methods or disciplines with which they are familiar. On the semantic level the physical and biological sciences can understand each other without difficulty as can the medical, psychiatric, and social sciences. However, to bridge the gap between the physical and biological sciences on the one hand and the psychological and social sciences on the other is very difficult. Through the Conference Program this Foundation hopes to foster communication and reintegration and . . . give a clearer reproduction than now appears in the scientific literature of what takes place in the laboratory and what goes on in the minds of scientists.

This reviewer found it interesting, pleasant, and highly stimulating to be "present" at a discussion conference while relaxing in an easy chair. Since a considerable amount of information was brought out through discussion, in addition to that presented in the formal reports, a summary of the material would only tend to underestimate the contents. The specific topics considered at the meetings were: "Some of the Problems Concerning Digital Notions in the Central Nervous System," Ralph W. Gerard; "The Manner in which and Extent to which Speech Can Be Distorted and Remain Intelligible," J. C. R. Licklider; "The Redundancy of English," Claude E. Shannon; "Experience in Learning Primitive Languages Through the Use of Learning High Level Linguistic Abstractions," Margaret Mead; "On the Development of Word Meanings," Heinz Werner; "The Development of Language in Early Childhood," John Stroud; and "The Relationship of Symbolic Function in Language Formation and in Neurosis," Lawrence S. Kubie.

In spite of the participants' different viewpoints and training, the discussions maintained a high level of intelligibility and continuity. In closing the meeting Fremont-Smith stated,

> I do feel that . . . we have come closer to a discussion in which there is a common denominator for every discipline here.

For this very reason, the volume should be of interest to scientists, regardless of their specific fields. The Josiah Macy, Jr. Foundation should be congratulated for making possible the conference and the publication of this book.

M. D. STEER

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The Kidney: Medical and Surgical Diseases. Arthur C. Allen. New York: Grune & Stratton, 1951. 583 pp. $15.00.

More than half this "text and atlas of renal disease" consists of lucid, well-ordered plates, mostly photomicrographs. The legends are brief but clear and descriptive. There are useful sections on renal anatomy, embryology, and malformations.

The aim of the book is to help clinicians in visualizing the lesions that cripple their patients, and morphologists in reconstructing the dynamic evolution of the static lesions they finally see.

Unfortunately but inevitably, "life is short, art is long"—too long now for uniform excellence in every one of its aspects. Here and there the text contains pronouncements that could mislead a trusting clinician or student; related references give the impression of an uncritical selection. On the other hand, the coverage of renal pathology is in general satisfying, and some sections, notably those on toxins, infections, diabetes, and tumors, equal the high standard of the illustrations. Pathologists will take exception to the term "membranous" as applied to glomerular disease (it is accurate but has unrelated and well-established associations), to classification of benign albuminuria as a glomerular disease and myeloma kidney as a distal tubular nephrosis, and to a concept of hyaline droplet formation that runs counter to current weighty evidence.

The handsome volume is therefore recommended as a comprehensive atlas which should be in the hands of all who have to do with renal disease. But they should salt their use of its text by reference to other guides, such as Fishberg, Addis, Oliver, Bell, and Smith.

A. C. CORCORAN

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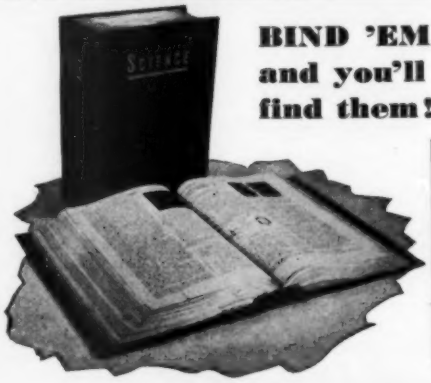

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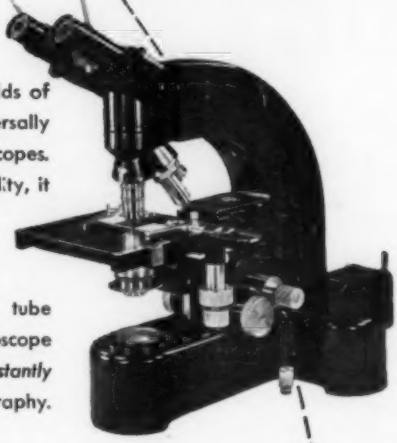

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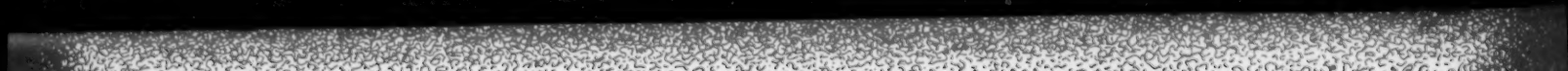
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